Potential Natural Vegetation of Eastern Africa (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Volume 9

Atlas and Tree Species Composition for Rwanda

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Collaborating Partners

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Introduction

This book represents **Volume 9** in a eleven-volume series that documents the potential natural vegetation map that was developed by the VECEA (Vegetation and Climate change in East Africa) project. The VECEA map was developed as a collaborative effort that included partners from each of the seven VECEA countries (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia).

- In **Volume 1**, we present the potential natural vegetation map that we developed for seven countries in eastern Africa. In Volume 1, we also introduce the concept of potential natural vegetation and give an overview of different application domains of the VECEA map.
- **Volumes 2** to **5** describe potential natural vegetation types, also including lists of the "useful tree species" that are expected to naturally occur in each vegetation type – and therefore also expected to be adapted to the environmental conditions where the vegetation types are depicted to occur on the map. **Volume 2** focuses on forest and scrub forest vegetation types. **Volume 3** focuses on woodland and wooded grassland vegetation types. **Volume 4** focuses on bushland and thicket vegetation types. In **Volume 5**, information is given for vegetation types that did not feature in Volumes 2 to 4.
- **Volume 6** gives details about the process that we followed in making the VECEA map.
- **Volume 7** shows the results of modelling the distribution of potential natural vegetation types for six potential future climates.
- **Volumes 8 to 11** provide a national atlas for four of the seven VECEA countries (Kenya, Rwanda, Tanzania and Uganda). We also provide a summary of the descriptions and species composition of potential natural vegetation types that occur in the species country.

We strongly encourage users of the VECEA map to get familiarized with all volumes. For example, as Volume 6 provides a detailed account of the process that we followed in creating the VECEA map, we have not repeated these details in the volumes that provide the national atlases.

Erratum (May 18, 2020): Authorships, localities and dates of photographs have been corrected in the figure captions for 9 different photos in volumes 2, 4, 5, 8, 9, 10, and 11.

Volume 2 Forest	Figures 6.1; 6.2; 20.1
Volume 4 Bushland	Figures 4.7; 7.4; 7.5; 7.8
Volume 5 Other	Figures 3.5; 4.2; 5.4
Volume 8 Kenya	Figures 8.1; 8.2; 16.1; 25.7; 26.4; 26.5; 26.6; 28.5; 29.2; 30.4
Volume 9 Rwanda	Figures 7.1; 7.2; 10.1; 14.7; 15.4; 15.5; 15.6; 16.5; 17.2
Volume 10 Tanzania	Figures 8.1; 8.2; 16.1, 26.7, 27.4; 27.5; 27.6; 30.5; 31.2
Volume 11 Uganda	Figures 8.1; 8.2; 11.1; 20.7; 21.4; 21.5; 21.6; 22.5; 23.2

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We also greatly appreciate the comments and suggestions that were made by Paul Smith and Jonathan Timberlake (both of Royal Botanic Gardens Kew) when they reviewed early drafts of volumes 2, 3, 4 & 5.

Thanks to anybody in our institutions who contributed directly or indirectly to the completion of the VECEA vegetation map and its associated documentation. We especially appreciate the assistance by Nelly Mutio (as for organizing logistics for the regional workshop that we organized in 2009 and for assisting in administrative issues), Melita Jørgensen (for desktop publishing), and of Jeanette van der Steeg for helping with the final preparation of the maps for Volume 1.

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Thanks to UNEP-GEF for funding the Carbon Benefits Project (CBP) through which information was compiled on indicator and characteristic species for The Vegetation Map of Africa (White 1983). (This work led to the publication in 2011 of an Africa-wide tree species selection tool that is available from: *http://www.worldagroforestrycentre.org/our_products/databases/ useful-tree-species-africa)* Thanks to BMZ for funding the ReACCT project in Tanzania through which funding was made available for field verification of the VECEA map around Morogoro (this was essential in preparing the VECEA map as the base map for Tanzania was essentially a physiognomic map.

We are grateful for the assistance provided by Meshack Nyabenge (ICRAF) and Jane Wanjara (ICRAF) for digitization of maps.

Abbreviations

Abbreviation	Full
A	Afroalpine vegetation
B	Afromontane bamboo
Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
Be	Evergreen and semi-evergreen bushland and thicket
bi (no capital)	Itigi thicket (edaphic vegetation type)
br (no capital)	Riverine thicket (edaphic vegetation type, mapped together with riverine forest and woodland)
C	In species composition tables: we have information that this species is a characteristic (typical) species in a national manifestation of the vegetation type
D	Desert
DBH	diameter at breast height (1.3 m)
E	Montane *Ericaceous* belt (easily identifiable type)
f (no capital)	In species composition tables: since this species is present in the focal country and since it was documented to occur in the same vegetation type in some other VECEA countries, this species potentially occurs in the national manifestation of the vegetation type
Fa	Afromontane rain forest
Fb	Afromontane undifferentiated forest (Fbu) mapped together with Afromontane single-dominant *Juniperus procera* forest (Fbj)
Fc	Afromontane single-dominant *Widdringtonia whytei* forest
fc (no capital)	Zanzibar-Inhambane scrub forest on coral rag (fc, edaphic forest type)
Fd	Afromontane single-dominant *Hagenia abyssinica* forest
Fe	Afromontane moist transitional forest
fe (no capital)	Lake Victoria *Euphorbia dawei* scrub forest (fe, edaphic forest type mapped together with evergreen and semi-evergreen bushland and thicket)
FeE	distinct subtype of Afromontane moist transitional forest in Ethiopia
FeK	distinct subtype of Afromontane moist transitional forest in Kenya
Ff	Lake Victoria transitional rain forest
Fg	Zanzibar-Inhambane transitional rain forest
Fh	Afromontane dry transitional forest
Fi	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest
FLD	Forest & Landscape (URL *http://sl.life.ku.dk/English.aspx)*
Fm	Zambezian dry evergreen forest
Fn	Zambezian dry deciduous forest and scrub forest
Fo	Zanzibar-Inhambane lowland rain forest
Fp	Zanzibar-Inhambane undifferentiated forest
Fq	Zanzibar-Inhambane scrub forest
fr (no capital)	Riverine forests (fr, edaphic forest type mapped together with riverine woodland and thicket)
Fs	Somalia-Masai scrub forest (Fs, mapped together with evergreen and semi-evergreen bushland and thicket)
fs (no capital)	Swamp forest (fs, edaphic forest type)
G	Grassland (excluding semi-desert grassland and edaphic grassland, G)
g (no capital)	Edaphic grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type, g)
GCM	General Circulation Models
GHG	greenhouse gas
gv	Edaphic grassland on volcanic soils (edaphic subtype, gv)
ICRAF	World Agroforestry Centre (URL *http://www.worldagroforestry.org/*)
IPCC	Intergovernmental Panel on Climate Change
L	Lowland bamboo
M	Mangrove

P	Palm wooded grassland (physiognomically easily recognized type)
PROTA	Plant Resources of Tropical Africa (URL *http://www.prota.org/*)
S	Somalia-Masai semi-desert grassland and shrubland
PNV	Potential Natural Vegetation
s (no capital)	Vegetation of sands (edaphic type)
SRES	Special Report on Emissions Scenarios
T	*Termitaria* vegetation (easily identifiable and edaphic type, including bush groups around *termitaria* within grassy drainage zones)
UNEP	United Nations Environment Programme (URL *http://www.unep.org/*)
VECEA	Vegetation and Climate Change in Eastern Africa project (funded by the Rockefeller Foundation)
Wb	*Vitellaria* wooded grassland
Wc	*Combretum* wooded grassland
Wcd	dry *Combretum* wooded grassland subtype
Wcm	moist *Combretum* wooded grassland subtype
WCMC	World Conservation Monitoring Centre (URL *http://www.unep-wcmc.org/*)
wd (no capital)	Edaphic wooded grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type)
We	Biotic *Acacia* wooded grassland
Wk	Kalahari woodland
Wm	Miombo woodland
Wmd	Drier miombo woodland subtype
Wmr	Miombo on hills and rocky outcrops subtype
Wmw	Wetter miombo woodland subtype
Wn	north Zambezian undifferentiated woodland and wooded grassland (abbreviation: undifferentiated woodland)
Wo	Mopane woodland and scrub woodland
wr (no capital)	Riverine woodland (edaphic vegetation type, mapped together with riverine forest and thicket)
Wt	*Terminalia sericea* woodland
Wvs	*Vitex - Phyllanthus - Shikariopsis (Sapium) - Terminalia* woodland (not described regionally)
Wvt	*Terminalia glaucescens* woodland (not described regionally)
Wy	Chipya woodland and wooded grassland
X	Fresh-water swamp
x (no capital)	In species composition tables: we have information that this species is present in a national manifestation of the vegetation type
Z	Halophytic vegetation
ZI	Zanzibar-Inhambane coastal mosaic (Kenya and Tanzania coast)

Contents

1. The rationale of the VECEA map

The VECEA map of eastern and southern Africa (Ethiopia, Kenya, Uganda, Rwanda, Tanzania, and Zambia) is the product of a project funded by The Rockefeller Foundation and implemented by Forest and Landscape Denmark, World Agroforestry Centre, Nairobi, and botanical experts in the seven countries. The project also benefited from previous support to botanists at the relevant departments at the universities of Makerere/Dar es Salaam by an ENRECA programme provided by Danida and previous support to Ethiopian Flora Project provided by SIDA/SAREC and through grants from the Carlsberg Foundation.

The documentation of the VECEA vegetation map consists of seven volumes. In this volume 1, we present the map, and we briefly discuss the important concepts utilised and applied in the map. In volumes 2 to 5, we provide a detailed documentation and discussion of the five major physiognomic vegetation categories and their variation in vegetation types as well as distribution of tree species in this framework. In volume 6, we describe the original maps that we have utilised for each country and we document and discuss the modelling procedures and processes. In volume 7, we model how vegetation types may develop under different climate change scenarios.

So why did we chose to make a regional vegetation map when similar maps have already been developed (Olson *et al*., 2001; Whittaker *et al*, 2005)? The most recent is the ecoregional approach developed by World Wildlife Fund (WWF), Nature Conservancy, and Conservation International. In WWF's terrestrial ecoregion scheme[1], White's vegetation map (and memoir) of Africa (White, 1983) - henceforth called the White map - serve as the basis for the ecoregions of the Afrotropics (Olson *et al*; 2001; Burgess *et al*. 2004). In this process the ecoregions map has mainly become a simplified version of the White map. A major objective of the White map is to provide a framework on a continental scale within which more detailed local studies can be conducted and compared and as such the map is suitable as a basis for describing the terrestrial ecoregions of Africa by capturing the broad-scale patterns of biological diversity and the ecological processes that sustain them.

We have taken the opposite approach of WWF's terrestrial ecoregion scheme by deconstructing[2] the White map into its more detailed parts. We have done this by utilising the same smaller maps as those that White utilised and to a large extent described in his text without directly mapping them. The VECEA map thus differs in terms of the spatial resolution, which allows us to break down the landscape into more well defined mapping units.

So why do we think that a higher resolution of the map is important? It is in the nature of the scale of the White map (1:5,000,000) that vegetation units on the map are heterogeneous in character and only broadly delineated and thus it is not possible to utilise the White map for a more detailed understanding of vegetation dynamics and species distributions, which is an understanding that is required if a map should be of importance for

1: See also *http://www.worldwildlife.org/science/ecoregions/ecoregion-conservation.html*

2: Our method can best be described by paraphrasing the term deconstruction (Derrida, 1967). The White map is an interpretation of reality and we explain it and provide a higher resolution map by revisiting the maps and botanical research that he used to make his map. The VECEA map is thus also an interpretation of reality, but at a higher resolution.

field implementation (see below for the intended uses of the VECEA map). Furthermore for practically all indigenous species in the region there is insufficient point location data available to make good estimates of their actual and potential distributions across landscapes. A higher resolution of maps and consequently more detailed predictions of species distribution, however, opens up a new discussion of how to interpret vegetation dynamics at the community level (see below for our discussion of Potential Natural Vegetation), but this discussion is unavoidable and necessary for successful field implementation. The great advantage of mapping at a higher resolution is that the interpretation of community dynamics becomes publicly available and can be disputed and tested. This is in contrast to ecoregion maps where managers of restoration projects and tree planters must make their own guesses based on very generalised recommendations.

In comparison with White, we have had the advantage of computer based technologies that has enabled us to provide a higher resolution for a very large geographic area. Based on our analysis, we are in overall agreement with White's methodology and approach and we will provide a detailed discussion of the VECEA map in a number of peer reviewed papers. The process of elaborating the regional map has been iterative. Almost all available relevant vegetation information for the VECEA countries from early 20th century and onwards were collated and digitised. The botanists prepared national maps based on their interpretation of available vegetation maps and botanical information. The preparation of the regional map was a process of harmonisation of nomenclature and interpretation of vegetation types in an interaction between the team members.

The main objective for preparing the map is utilitarian and closely related to the requirement for a more detailed understanding of the indigenous tree species in the region – to improve the productivity of smallholder tree growers utilising the species in agroforestry systems. The utility of the map, however, goes beyond understanding the productivity of indigenous tree species and encompasses a more general understanding of agricultural productivity and conservation of fauna and flora in ecosystems.

In summary, the utility of the VECEA vegetation map, complemented with additional information on vegetation development and other environmental data layers, is that it:

(i) provides an integrated interpretation of landscapes and indicates the position of transitions between areas with significantly different environmental conditions, conditions which are most likely to be important determinative factors for agricultural potential;
(ii) predicts potential distributions of indigenous plant species in the agricultural landscapes and predicts possible genetic variation across distributional ranges;
(iii) can be a tool for predicting potential distributions of species of terrestrial animals, birds, reptiles, and invertebrates in remaining natural vegetation;

(iii) can be a user friendly extension tool for improving the potential options (both from indigenous and exotic species) available to farmers in their quest for improving livelihoods and income generation;
(iv) provides for possible forecasts of changes in agricultural potential resulting from climate change;
(v) provides a management tool for interpretation of historical, current, and future distribution of ecosystems and ecoregions, including alternative stable states;
(vi) provides a tool for ecological restoration and protection of ecosystems.

2. Definition of forest, woodland, wooded grassland, bushland and thicket

Forests are continuous stands of trees at least 10 m tall with interlocking crowns (White 1983 p. 46). White (1983 p. 46) distinguishes **scrub forests** that are intermediate in structure between forest and bushland (and thicket). They are usually 10 - 15 m high. Trees (woody plants with well-defined and upright boles) are usually present but do not form a closed canopy. Smaller woody plants (principally bushes and shrubs) contribute at least as much as the trees to the appearance of the vegetation and its phytomass.

Woodlands are open stands of trees of at least 8 m tall with a canopy cover of 40 percent or more(1), but never with interlocking crowns and usually with a field layer of heliophilous ('sun-loving') grasses. Woodlands have similar height as **forests**, but woodlands never have densely interlocking crowns (although the crowns can be in contact). White (1983 p. 46) distinguishes **scrub woodlands** that are intermediate in structure between woodland and bushland, being stunted variants (< 8 m) of main woodland vegetation types (i.e. containing the same dominant tree species).

Bushlands are open stands of bushes (usually between 3 and 7 m tall) with a canopy cover of 40 percent or more. **Thickets** are closed stands of bushes (usually between 3 and 7 m tall) where the bushes are so densely interlaced that they are impenetrable - except along tracks made by animals. Bushlands and thickets are taller than **shrublands** defined as open or closed stands of shrubs up to 2 m tall (White 1983 p. 46).

Wooded grasslands are lands covered with grasses and other herbs with woody plants (trees [≥ 7 m tall], bushes [3 - 7 m], dwarf trees, palm trees or shrubs [≤ 2 m]) covering between 10 and 40 percent of the ground. Woody plants nearly always occur scattered (White 1983 pp. 46, 47 and 52).

Grasslands are defined as lands covered with grasses and other herbs and where woody plants do not cover more than 10% of the ground (White 1983 p. 46).

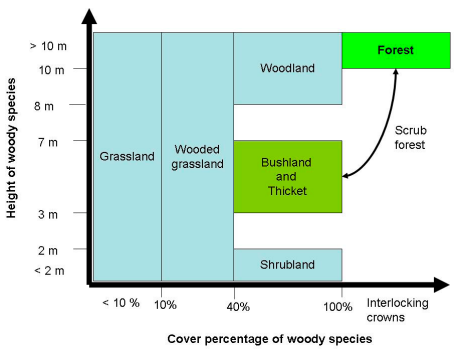


Figure 1. Height and cover percentage limits for major physiognomic types. Scrub forest is defined as a physiognomic mosaic of forest and bushland and thicket

3. What is potential natural vegetation?

We will here attempt to clarify how we interpret and implement terms utilised in the classification of vegetation. The central concept "Potential Natural Vegetation" in the VECEA map can be seen as the pivot around which a whole range of contested assumptions circle. These unavoidable assumptions are concerned with the distribution and dynamics of species and vegetation. While it is indisputable that plants are not randomly distributed geographically and in time, there is an ongoing debate about at what scale patterns can be discerned and whether plant species form assemblies that follow similar distribution patterns.

Friis (1998) in his review of the development of chorology explains that one of the earliest disputes in botany was about classifying plant distributions (plant chorology). In the beginning of the 19th century J.F. Schouw divided the globe into areas with more or less defined floras. Some of the most important criteria were based on presence or absence of characteristic species and without making assumptions about the historical development of the flora. Some twenty years later in a large work on plant geography A. de Candolle completely rejected a natural classification of the world into phytochoria because. (i) the plant world was too poorly known, and (ii) scientists did not apply sufficiently logical criteria. During the following century many scholars further contributed to the understanding of plant chorology in Africa and there is now a general consensus on chorology as a useful tool to describe plant species distributions in Africa - contrary to the situation in Europe (Friis, 1998). Frank White has been a major contributor and chorological patterns are an important integral part of White's vegetation map. Although logical, the criteria utilised are still not completely objective in the strictest sense. As Friis points out, White more than once stated that "there is no *a priori* reasons why the pattern lines on a vegetation map based on physiognomy of vegetation should coincide closely with those of a chorological map based on the coinciding distributional limits of species." But the results of his work with the vegetation map of Africa showed that if the chorological map of Africa was based on chorological data alone, rather than on transferring pattern lines from a detailed vegetation map, the pattern lines would not have been significantly different" (Friis, 1998 p. 37).

Early concepts concerned with the definition of community patterns in space are the biome[3], that was introduced to plant ecology by Clements in the first half of the 20th century and ecoregion that was introduced by Crowley, and Bailey in the second half of the same century (see discussion in Pennington *et al.,* 2004). The concepts are largely overlapping and assume that one can discern broad scale patterns in the distribution of ecological communities, which are defined by similar climax plant formations and environmental conditions. A major difference is that an ecoregion is never discontinuous, while a biome is in principle always coincident with the climax vegetation and therefore can consist of disjunct areas (Bailey, 2005). Biomes

3: Biome, also called major life zone, the largest geographic biotic unit, a major community of plants and animals with similar life forms and environmental conditions. It includes various communities and is named for the dominant type of vegetation, such as grassland or coniferous forest. Several similar biomes constitute a biome type - for example, the temperate deciduous forest biome type includes the deciduous forest biomes of Asia, Europe, and North America. "Major life zone" is the European phrase for the North American biome concept (*http://www.britannica.com*, accessed November 14, 2011).

and ecoregions define very large scale patterns, thus allowing for analysis at a continental or global scale, and are widely used by conservation agencies.

During the first part of the 20th century Clement and later Tansley[4] envisaged that in a given area, the assemblage of plant species would compete and replace each other such that eventually the dominant species would coexist in a stable climax (equilibrium/balance of nature), which would vary with the biotic and abiotic environment including the prevailing climate. This climax concept was soon after contested by Gleason who saw vegetation development as a stochastic process rather than as development as an organism, with communities composed of species with individual adaptations to the biotic and abiotic environment and thus with individual distributions. During the almost one hundred years since these ideas were conceived an enormous amount of studies and theoretical developments have modified our understanding of vegetation dynamics and it is unlikely that any scholar today would understand the term 'climax vegetation' in the same way as Clement and Tansley did. Already Whittaker (1962) in a review of the field of vegetation classification largely corroborated Gleason's view. This concept of the flux of nature led to interest in theories where disturbance is seen as a permanent feature of vegetation such as patch dynamics and patterns and processes in forest (Cadenasso *et al.*, 2003, Whitmore, 1982, van der Maarel, 1996). However, a non-equilibrium view does not preclude that there can be patterns of coinciding distribution of species, such that vegetation types can still be identified (Walker & Del Moral, 2003; Chadzon, 2008).

The concept of Potential Natural Vegetation (PNV) is part of this development of vegetation science. A widely accepted definition of PNV is: Potential natural vegetation has been defined as the vegetation structure that would become established if all successional sequences were completed without interference by man under the present climatic and edaphic conditions, including those created by man (van der Maarel, 2005). The term was coined by Tüxen in the middle of the 20th century (Tüxen, 1956) and has been applied in many parts of the world to categorise plant communities. The concept is closely related to the schools of phytosociology, which originated in Europe and elaborated methods for vegetation analysis and detailed and often hierarchical systems of classification of vegetation by floristic and physiognomic characteristics (see reviews by van der Maarel, 2005; Whittaker, 1980). We do not consider the reintroduction of the PNV concept as a statement about the degree of niche assembly of ecological communities versus a stochastic neutral theory (sensu Hubbell, 2008) but as a tangible hypothesis about species distributions.

We believe that there is truth in the concepts of climax and PNV as well as in the critique and that for practical conservation and management of vegetation and species this discussion should not only be a theoretical discussion, but should be lead to a more informed interpretation of 'real' landscapes. The dichotomy between the continuum concept and the concept of communities as co-occurring species can in principle be solved by considering the two concepts as two different and complementary ways of looking at the same landscape (after Austin, 2005, pp. 66-67): The continuum concept applies to an

4: **Ecosystem**, the complex of living organisms, their physical environment, and all their interrelationships in a particular unit of space. The concept of ecosystems, introduced by Tansley, not only considers the complex of living organisms and their physical environment, but also all their relationships in a particular unit of space (*http://www.britannica.com*, accessed November 14, 2011).

abstract environmental space, not necessarily to any geographical distance on the ground or to any indirect environmental gradient. The abstract concept of community of co-occurring species can only be relevant to a particular landscape and its pattern of environmental variables, community is a property of the landscape. Such a community concept is compatible with the different concepts of a continuum. The PNV map thus offers a useful tool in lieu of missing environmental relationships. For the forests we have been careful not to map the detailed variation of the forest types, but have kept the physiognomic and chorological classification of White (1983). As pointed out by Langdale Brown and Omaston "The forests are characterised by a great variety of species and communities. Sometimes edaphic or seral relationships between these types are clear, but we cannot yet account for all the differences. Indeed these tropical forests are such complex and longlived communities that in many cases it is not yet possible to be sure what is the climax; even the very nature and constancy of the climax is in doubt." (Langdale Brown & Omaston, 1964 p. 36).

The 'Clementian' traits of interpreting PNVs are in particular (i) the use of rigid hierarchical systems of classification together with a rigid prescription of species composition, and (ii) a static view that there can be only one endpoint to succession. We suggest that the PNV concept should not be interpreted in terms of a static 'Clementian' paradigm and we have been helped in this by the non-hierarchical classification utilised by White. The largest part of the VECEA region is covered by dry vegetation where fire and large browsers (megaherbivores) have profound influence on vegetation development (Bond *et al.*, 2005, Owen-Smith, 1987) and there may in most cases be more than one stable state for the vegetation of a particular area. The use of PNV can thus be an aid in interpreting the dynamics of vegetation and likely alternative stable states. In the Serengeti-Mara area the possibility of alternative stable states has been convincingly documented (Sinclair *et al.*, 2007, McNaughton *et al.*, 1988, Dublin *et al.*, 1990) and the VECEA map could be a tool for identifying alternative stable states in other areas.

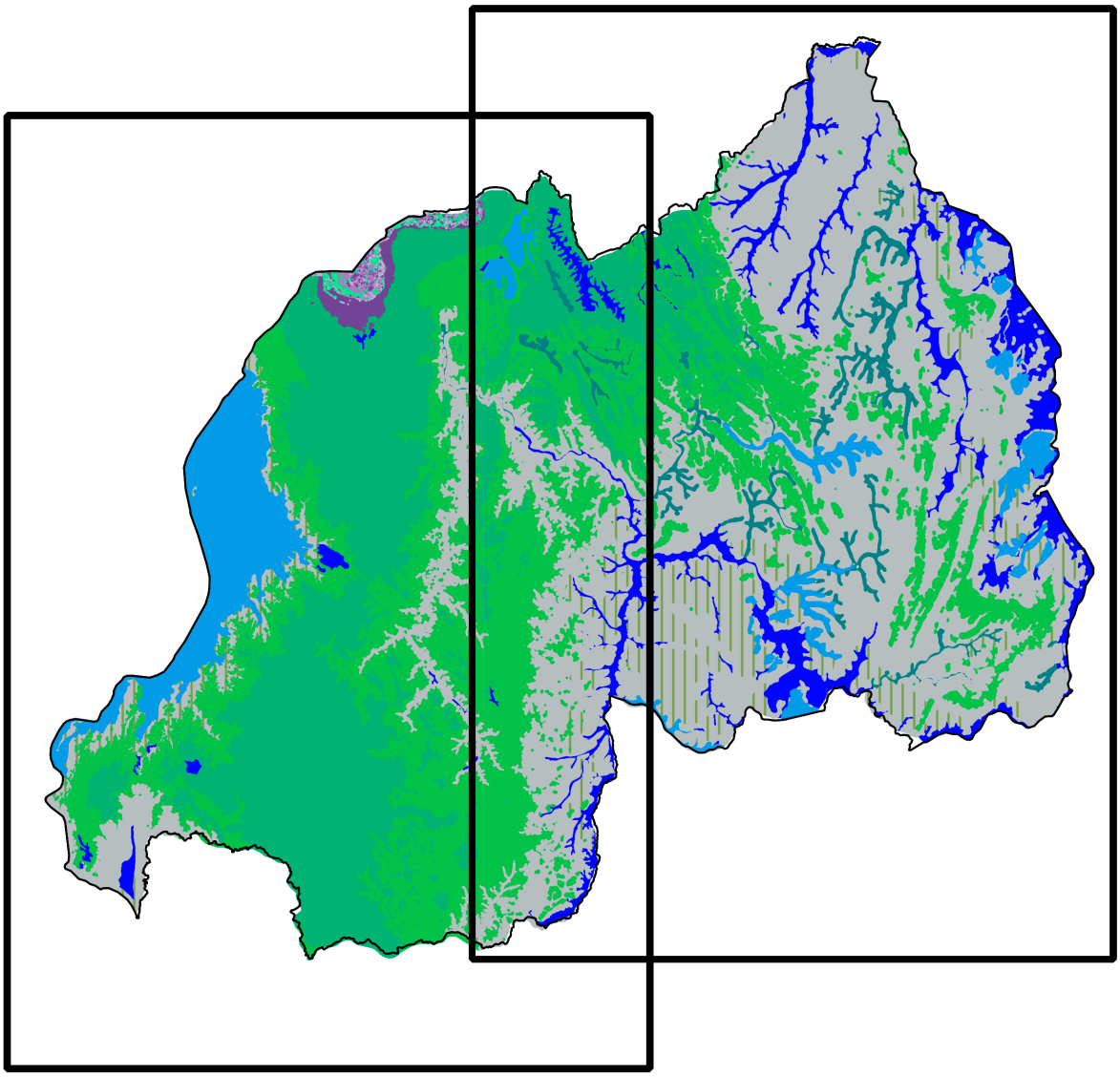
With the VECEA vegetation map we suggest that the interpretation of landscapes is done at such a resolution that the implications of analyses can be transferred directly to the landscapes. In making a map with this level of detail we have entered the domain of the contested concepts (climax, continuum, species assembly rules, non-equilibrium communities, etc), which may otherwise be avoided at the biome/ecoregional level of analysis (but not in the implementation and management of patterns and processes in actual landscapes). We do not claim that we have completely solved the conundrum with our map, but we trust that we have created a tool that can be an aid in biogeographical analyses.

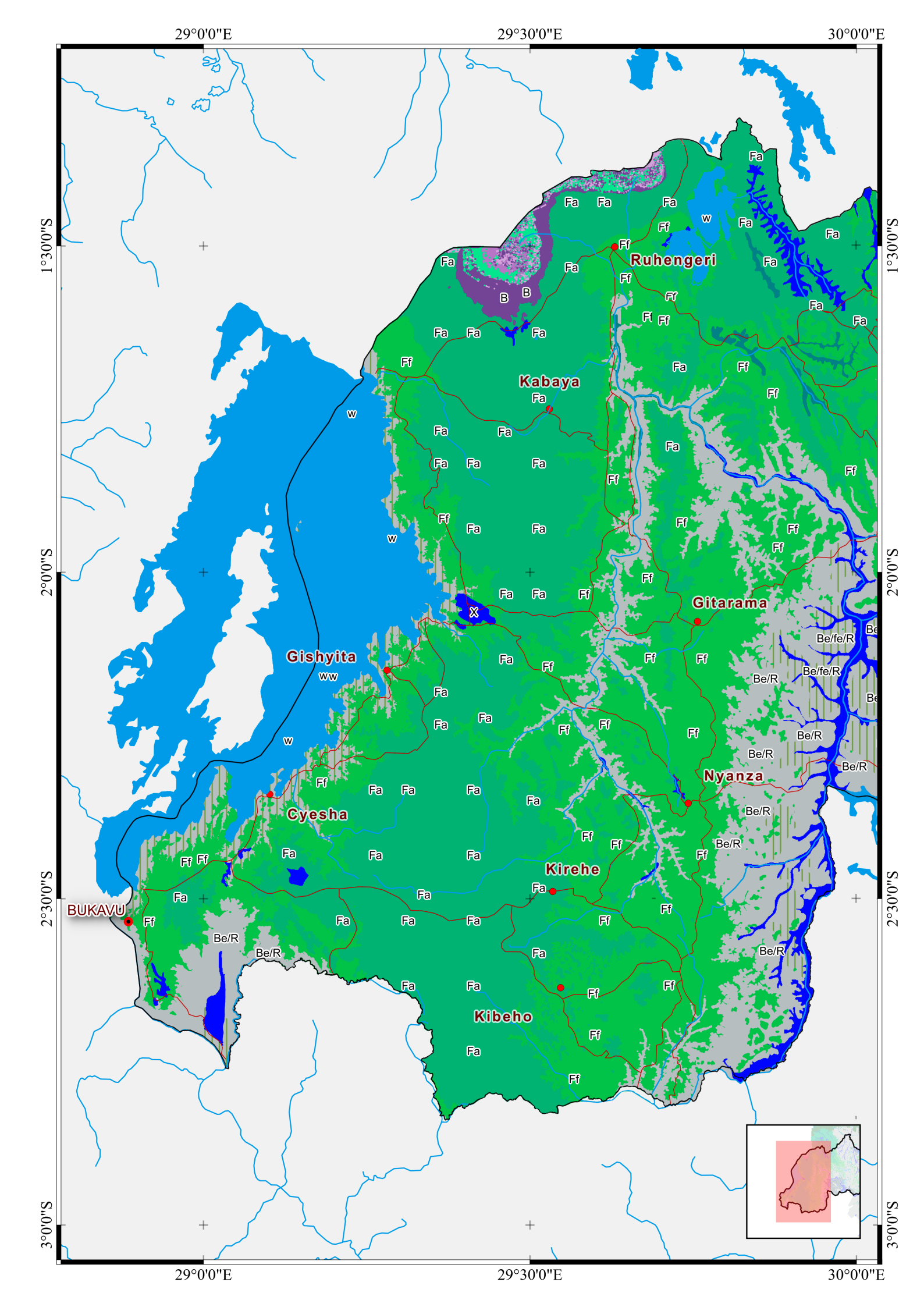
When the concepts, biome, plant community, and PNV are defined very loosely (as they are often used in practice) they are almost interchangeable in the sense that they all attempt to describe the variation in vegetation that can be experienced as one moves through a landscape. The use of the two first concepts is rarely questioned - because of the underlying objectives and the scale at which they are used – as they are rarely utilised in a context

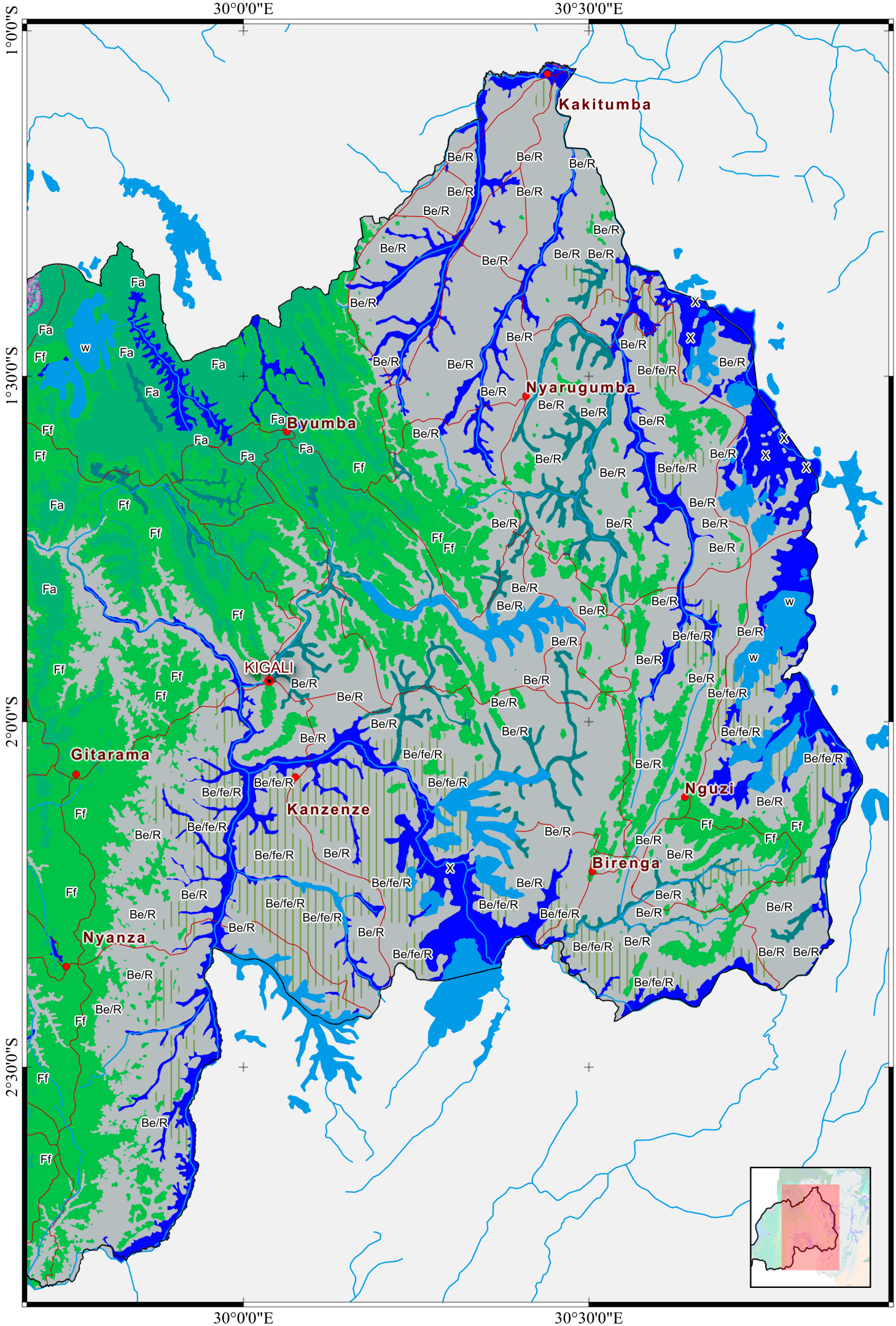
where they need to be applied in a particular landscape. PNV on the other hand, by nature of its use to describe plant communities on large scale, immediately invokes an interpretation of pattern and process. Like the concept of chorology, the concept of PNV is logical, but the criteria utilised can not be completely objective in the strictest sense. This is to us an acceptable compromise, since nature includes a large degree of history and chance and we suggest that the PNVs are tested and corroborated through empirical tests as well as modelling.

The PNV concept offers a tool that can be utilised in analysing the pattern and processes in landscapes including the biotic and abiotic interrelationships that govern these ecosystem aspects. As such it complements and can be used as an input to modelling of ecosystems and individual species. Although we are confident that the VECEA map provides a realistic picture of where particular vegetation types occur, the map still is a hypothesis about what the actual vegetation type will be. This is an inherent consequence of trying to map anything.

4. Maps of Rwanda




29°0'0"E
29°30'0"E
30°0'0"E
1°30'0"S
2°0'0"S
2°30'0"S
3°0'0"S
Ruhengeri
Kabaya
Gitarama
Gishyita
Nyanza
Cyesha
Kirehe
BUKAVU
Kibeho
Fa
Ff
w
B
X
Be/R
Be/fe/R


30°0'0"E
30°30'0"E
1°0'0"S
1°30'0"S
2°0'0"S
2°30'0"S
Kakitumba
Nyarugumba
Byumba
KIGALI
Gitarama
Kanzenze
Nguzi
Birenga
Nyanza
Be/R
Be/fe/R
Fa
Ff
w
X

5. Description and species list for Rwanda

5.1. Methodology

For each of the vegetation types, we obtained information on species assemblages (those tree species expected to occur in a particular vegetation type) based on information that was provided in the national references (details are provided in Volumes 2 to 5). For each of the countries where we had information on the national "manifestation" of a vegetation type (for example, Afromontane rain forest as it was described for Ethiopia by Friis et al. 2010), we created a separate column within which we gave an indication that a particular tree species was expected to occur within that vegetation type and within that country.

Where species were not listed in the national reference for a focal country, we checked with information on national lists of all the tree species that occur in the focal country whether the species could **potentially** occur in the focal vegetation type and focal country **because the species was documented to occur in the same vegetation type in other countries**. For example, the species *Cyathea dregei* was documented to occur in Afromontane rain forest in Malawi, Rwanda and Zambia. From the UNEP-WCMC species database, there was information that this species also occurs in Ethiopia. This led us to indicate that there was information that the species potentially occurred in Afromontane rain forest in Ethiopia (we used the coding of "f" in the species assemblage table to indicate this). **Note that it is possible that species indicated with "f" for a particular country and forest type do NOT occur in that particular country and forest type in reality (meaning that, in reality, differences exist between species assemblages of the same forest type between countries – or possibly indicating errors in the obtained species assemblage for a particular country).**

After compiling information on species assemblages, we selected a subset of species to feature in species composition tables. These were mainly "useful tree species", which are tree, bushland or liana species that were listed in at least one of the references that we consulted on tree species that are expected to be useful to farming or pastoral communities in the VECEA countries

Information that is provided in species composition tables was simplified from the information provided in Volumes 2 to 5, providing the following types of information:

- "x" in a species composition tables indicates that the species is expected to occur in the vegetation type based on references that we consulted or field experience from a national collaborator
- "C" in a species composition table indicates that the species is a characteristic species for the vegetation type (see Volumes 2 to 5 for details)

- "f" in a species composition table indicates that the species was not initially listed for the country, but could potentially occur because the species is known to occur in that particular country
- A "characteristic species" is a species that was listed for the focal vegetation type in a regional description of potential natural vegetation (this regional description was typically White 1983)
- A species that is "not characteristic" is a species that was not listed for the focal vegetation type in a regional description of potential natural vegetation
- An "indicator species" was defined as a characteristic species that was only listed once (i.e. for the focal vegetation type) among all the vegetation types of the same physiognomic classification and the same floristic region. For example, Chrysophyllum gorungosanum is an indicator species for Afromontane rain forest since this species was only listed for Afromontane rain forest (White 1983 p. 164) among all the forests described for the Afromontane floristic region.

Another modification from the species composition tables that were given in Volumes 2 to 5 is that we excluded species that were listed to be present (coding "x" or "C") in fewer than 50 percent of all the countries in which the vegetation type occurs. We implemented this change to increase consensus among national manifestations of the focal vegetation type (and especially to filter out marginal occurrence of a species), and also to increase confidence about the regional occurrence of a species. Although this approach has led to better agreements between national documentation, we may have excluded some species that widely occur in some situations (please compare the abbreviated lists provided here with the more comprehensive lists provided in Volumes 2 to 5 if you are particularly interested in these species).

6. Afromontane rain forest (Fa)

6.1. Description

Afromontane rain forest is very similar in structure (physiognomy) to certain types of Guineo-Congolian rain forest. Species composition, however, is almost entirely different (many tree genera have different species in Afromontane rain forest and Guineo-Congolian rain forest, on the other hand). Other physiognomic and floristic differentiation between Afromontane rain forest and Guineo-Congolian rain forest include the greater degree of bud protection, a lesser degree of drip tips of leaves development, the occurrence of tree ferns (*Cyathea*) and the occurrence of conifers (*Podocarpus*; especially *Podocarpus latifolius* as *Podocarpus falcatus* (synonym: *P. gracilior*) are more characteristic of Afromontane undifferentiated forest; White 1983 p. 164 - 165).

These forests occur mainly between 1200 and 2500 m on the slopes of certain mountains. However, the altitudinal limits vary greatly according to distance from the equator, proximity to the ocean, and size and configuration of the massif on which these forests occur (White 1983 p. 164). The observation that vegetation belts are scaled according to the size of the mountain on which they occur were first observed in the Alps, where this phenomenon is described as the 'Massenerhebung effect' (mass-elevation effect). The mean annual rainfall lies mostly between 1250 and 2500 mm. Mists that frequently occur during the dry season of one to five months may explain the fact that Afromontane rain forest is much less deciduous than lowland semi-evergreen forests that receive similar rainfall. Only a few of the larger tree species (*Entandophragma excelsum* and *Pouteria adolfi-friedericii*) lose their leaves - and then only for a few days (White 1983 p. 164).

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Afromontane rain forest and no other Afromontane forest types) that were listed as characteristic species for one or several national maps include ***Chrysophyllum gorungosanum*, *Cola greenwayi*, *Cylicomorpha parviflora*, *Entandrophragma excelsum*, *Ficalhoa laurifolia*, *Hallea rubrostipulata*, *Myrianthus holstii*, *Ochna holstii*, *Ocotea usambarensis*, *Olea capensis*, *Parinari excelsa*, *Pouteria adolfi-friedericii*, *Strombosia scheffleri*, *Syzygium guineense* subsp. *afromontanum*** and ***Tabernaemontana stapfiana***.

Figure 6.1. View of canopy from Afromontane rain forest (synonym: moist evergreen Afromontane forest) north of Masha (Ethiopia). Altitude approximately 1950 m. Photograph by I. Friis and Sebsebe Demissew (September 2002). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 25A. 2010.

Figure 6.2. Afromontane rain forest in Nyungwe National Park (Rwanda). Photograph by C. K. Ruffo (June 2008).

Figure 6.3. *Cyathea manniana* tree ferns in Lake Victoria transitional rain forest (Ff). The presence of tree ferns (*Cyathea* species) is typical for Afromontane rain forest (White 1983 p. 164). However, this species also occurs in other types of forests with admixture of Afromontane species. Photograph by F. Gachathi (2009).

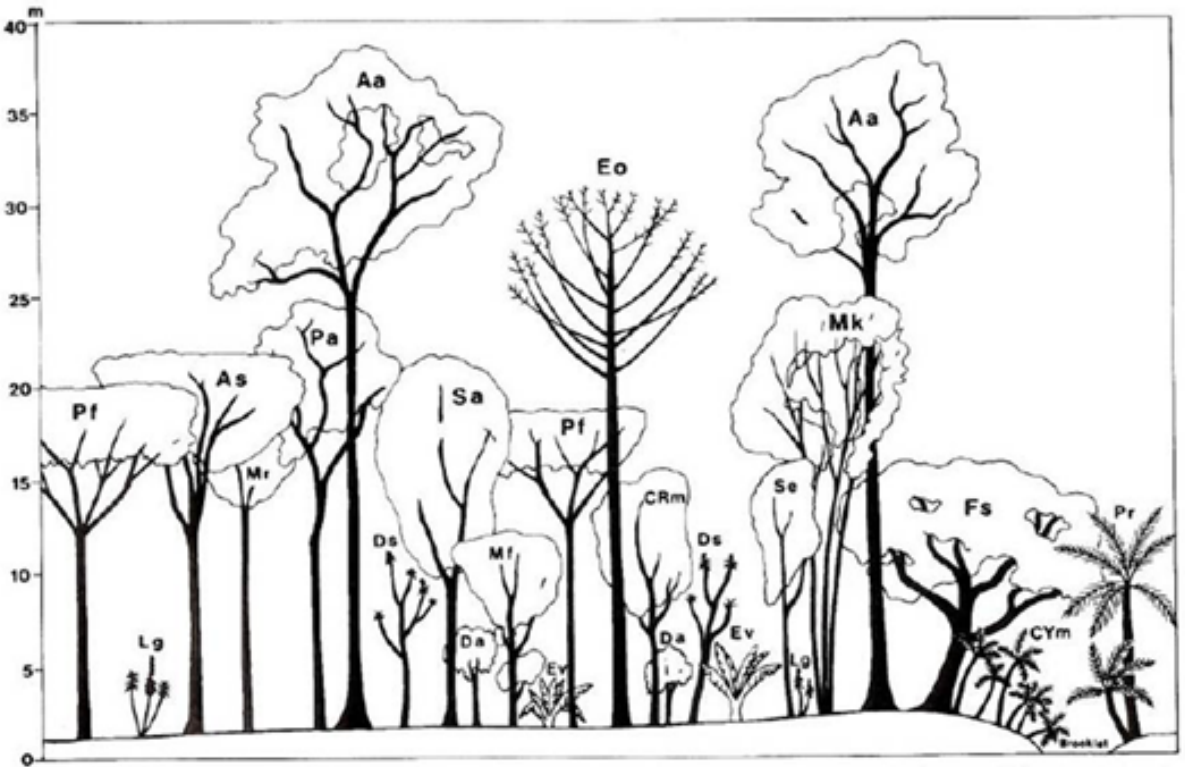


Figure 6.4. Transect of Primary or mature secondary moist evergreen Afromontane forest (classified in VECEA as Afromontane rain forest [Fa]). Generalised representation based on observations made in old secondary forest at approximately 1700 metres altitude south of Gore, IL floristic region. Although this locality is situated just below the altitudinal limit used for mapping (6) Moist evergreen Afromontane forest (Fa) no species restricted to (7) Transitional rain forest (mapped in VECEA as Afromontane moist transitional forest [Fe]) were observed, but a few species, for example *Hallea rubrostipulata*, are known from both vegetation types. The abbreviated names for the species stand for: Aa: *Pouteria (Aningeria) adolfi-friederici*. As: *Albizia schimperiana*. CRm: *Croton macrostachyus*. CYm: *Cyathea manniana*. Da: *Dracaena afromontana.* Ds: *Dracaena steudneri*. Eo: *Euphorbia ampliphylla*. Ev: *Enset ventricosum*. Fs: *Ficus sur*. Lg: *Lobelia giberroa*. Mf: *Millettia ferruginea.* Mk: *Macaranga capensis* var. *kilimandscharica*. Mr: *Hallea (Mitragyna) rubrostipulata*. Pa: *Prunus africana*. Pf: *Polyscias fulva*. Pr: *Phoenix reclinata*. Sa: *Schefflera abyssinica*. Sa: *Sapium ellipticum*. Drawn by Victoria C. Friis. Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 24. 2010.

6.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 6. Species composition of Afromontane rain forest (Fa)

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania (FarT subtype)	Tanzania (FawT subtype)	Uganda	Zambia
Chrysophyllum gorungosanum	indicator species		C	C	x	x	f	C	f
Cola greenwayi	indicator species		C	C		x	f		C
Cylicomorpha parviflora	indicator species		C	x		f	f		
Entandrophragma excelsum	indicator species			C	C	f	f	C	f
Ficalhoa laurifolia	indicator species			C	C	x	C	f	f
Hallea rubrostipulata	indicator species	C	x	x		x	f	f	
Myrianthus holstii	indicator species		x	x	x	x	f	f	f
Ochna holstii	indicator species	x	C	x	x	x	C	f	f
Ocotea usambarensis	indicator species		C	C	C	x	C	f	f
Olea capensis	indicator species	C	C	C	C	f	C	C	f
Parinari excelsa	indicator species			C	C	x	f	f	C
Pouteria adolfi-friedericii	indicator species	C	C	C	x	C	C	C	C
Strombosia scheffleri	indicator species		C	C	C	x	f	C	
Syzygium guineense	indicator species (*Syzygium guineense* ssp. *afromontanum*)	C	C	x	C	x	f	x	f
Tabernaemontana stapfiana	indicator species		C	x	x	f	f	x	
Diospyros abyssinica	characteristic species	x	C	x	f	f	f	f	f
Podocarpus latifolius	characteristic species (conifer species that is absent from Guineo-Congolian rain forest, but more characteristic of other types of Afromontane forest)		C	C	C	f	C	C	C
Prunus africana	characteristic species	C	C	C	C	f	x	C	f
Xymalos monospora	characteristic species		C	x	C	x	C	x	f
Acacia abyssinica	invasive species	x	C	x	f	f	f	f	
Acacia lahai	invasive species	f	x			f	f	f	
Agauria salicifolia		f	x	x	x	f	x	f	C
Albizia grandibracteata		C	x		f	f	f	f	
Albizia gummifera	not characteristic	C	C	C	f	x	f	C	f
Albizia schimperiana		C	f	C		f	f	f	f
Alchornea hirtella			x	x	x	f	f	f	f
Allophylus abyssinicus		x	C	x	x	f	f	x	f
Allophylus africanus		f	C	f	f	f	f	f	f
Anthocleista grandiflora			C	x		x	f	x	
Apodytes dimidiata	not characteristic	x	C	C	x	f	f	f	f
Balthasaria schliebenii							C		
Berberis holstii		f	x	x		f	f	f	
Bersama abyssinica		x	C	x	x	x	x	C	f
Blighia unijugata		x	x	f	f	f	f	f	f
Bridelia brideliifolia				x	C	f	C	f	
Carapa procera					C	f	f	f	
Casearia battiscombei			C	x		f	f	f	
Cassipourea malosana	not characteristic	C	C	C		f	C	x	f
Cassipourea ruwensoriensis		f	f		C	f	f	f	
Catha edulis		f	C	x	f	f	f	f	f
Celtis africana		C	C	C	f	f	f	f	f
Celtis gomphophylla		f	x	x	f	f	f	f	f
Clausena anisata		x	x	x	x	f	f	x	f
Cordia africana		x	x	f	f	f	f	f	f
Cornus volkensii			C	C	x	x	f	f	
Croton macrostachyus		C	C	C	x	f	f	x	f
Croton megalocarpus	not characteristic		f	x	x	f	f	f	f
Croton sylvaticus		f	C	x		f	f	f	f
Cussonia spicata			x	C		f	f	x	f
Cyathea dregei	tree fern that is characteristic of Afromontane rain forest and that is absent from Guineo-Congolian rain forest	f	f	x	x	f	f		f
Cyathea humilis	tree fern that is characteristic of Afromontane rain forest and that is absent from Guineo-Congolian rain forest		x			f	f		
Cyathea manniana	tree fern that is characteristic of Afromontane rain forest and that is absent from Guineo-Congolian rain forest	x	x	x	x	f	f	C	
Discopodium penninervium		f	x	x	x	f	f	f	
Dodonaea viscosa		f	f	x	x	f	f	f	f
Dombeya torrida		x	C	x	x	f	C	x	
Dovyalis abyssinica		f	x	x		f	f	f	f
Dovyalis macrocalyx			x	x	x	f	f	f	f
Dracaena fragrans		x	f	x	f	f	f	f	
Dracaena steudneri		x	C	x	x	f	f	x	f
Ehretia cymosa		x	C	x	x			f	
Ekebergia capensis		C	C	C	x	f	f	x	f
Elaeodendron buchananii		x	f	x	f	f	f	f	f
Embelia schimperi		f	x	x	x	f	f	f	f
Ensete ventricosum		x	f	x	x	f	f	f	f
Eugenia capensis		x	f	x	x	f	f	f	f
Euphorbia abyssinica		f	C	x		f	f	x	f
Fagaropsis angolensis	not characteristic	x	f	x	x	f	f	f	f
Ficus exasperata		f	x	f	x	f	f	f	f
Ficus natalensis			x	x	x	f	f	f	f
Ficus ovata		C	f	x	f	f	f	f	f
Ficus sur		C	C	x	f	f	f	f	f

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania (FarT subtype)	Tanzania (FawT subtype)	Uganda	Zambia
Ficus thonningii		C	C	C	f	f	f	f	f
Galiniera saxifraga		x	C	x	C	f	f	C	
Garcinia buchananii		x	x	f	f	f	f	x	f
Hagenia abyssinica		f	C	C	C	f	f	f	f
Harungana madagascariensis			C	f	f	f	f	f	f
Hypericum revolutum		f	f	x	x	f	f	f	f
Ilex mitis	not characteristic	C	x	C	x	f	C	x	f
Kigelia moosa			C			f	f	f	
Landolphia buchananii		x	f	x		f	f	f	f
Lepidotrichilia volkensii		x	C	x	x	f	f	C	f
Macaranga capensis		f	C	C	C	x	C	C	f
Maesa lanceolata		x	C	f	x	f	C	x	C
Manilkara butugii		x	x					f	
Maytenus acuminata			C	C	x	f	C	x	f
Maytenus undata		x	x	x	x	f	f	f	f
Milicia excelsa		f	x	x	f	f	f	f	
Millettia dura			x	x	f	f	f	f	
Neoboutonia macrocalyx			C	C	C	x	f	x	f
Newtonia buchananii	not characteristic		x	f	x	x	f	f	f
Nuxia congesta	not characteristic	x	C	x	x	f	C	f	f
Nuxia floribunda	not characteristic		f	x	x	f	f	f	f
Ocotea kenyensis	not characteristic	C	C	x	x	f	x	f	
Olea europaea	not characteristic	f	C	x	f	f	f	f	f
Olinia rochetiana		f	f	x	x	f	x	f	f
Peddiea fischeri			x		x	f	f	f	f
Phoenix reclinata	palm species	x	x	x	f	f	f	f	f
Phytolacca dodecandra		f	x	x	f	f	f	f	f
Pittosporum viridiflorum		x	x	x	x	f	x	C	f
Pleiocarpa pycnantha			x		x	f	f	f	f
Podocarpus falcatus	not characteristic	x	x	x	C	C	f	f	
Podocarpus henkelii	conifer species that is absent from Guineo-Congolian rain forest, but more characteristic of other types of Afromontane forest; species that is very localized north of the Limpopo river			C					
Podocarpus usambarensis	conifer species that is absent from Guineo-Congolian rain forest, but more characteristic of other types of Afromontane forest		x			f	f	f	
Polyscias fulva		C	f	C	C	x	f	x	f
Pouteria altissima		f	f		f	f	f	f	C
Psychotria mahonii			C	x	x	f	x	C	f
Psydrax parviflora		f	C	x	x	f	f	f	f
Pterolobium stellatum		f	x	x	f	f	f	f	f
Rapanea melanophloeos	not characteristic	f	C	C	x	f	C	x	f
Rauvolfia caffra			f	x		x	f	f	f
Rhamnus prinoides		x	x	x	x	f	f	x	f
Rinorea angustifolia			x		x	f	f	f	
Ritchiea albersii		x	x		x	f	f	f	f
Rothmannia urcelliformis		x	f	x		f	f	f	f
Rubus apetalus		f	x	x	x	f	f	f	f
Sambucus ebulus			x			f	f	f	
Schefflera abyssinica		C	C	C		f	f	x	f
Schefflera volkensii		x	C			f	f	C	
Scutia myrtina		f	x	x	f	f	f	f	f
Shirakiopsis elliptica		C	x	x	x	f	f	f	f
Sinarundinaria alpina	Afromontane bamboo	C	f	x	x	f	f	x	
Smilax anceps		x	x		x	f	f	f	f
Solanecio mannii		x	f	x	f	f	f	f	f
Solanum aculeastrum			x	x	x	f	f	f	
Symphonia globulifera					C	f	C	C	f
Synsepalum brevipes			C	f		f	f	f	f
Syzygium cordatum							C		f
Tabernaemontana pachysiphon			C	f		f	f	f	f
Trema orientalis		x	x	f	x	f	f	f	f
Trichilia dregeana		x	x	f		f	f	f	f
Vangueria apiculata		f	f	x	x	f	f	f	f
Vepris nobilis		x	C	x	x	f	f	f	f
Vernonia auriculifera		x	x		x	f	f	f	
Vernonia myriantha		x	x	x	x	f	f	f	f
Vitex keniensis			C						
Zanthoxylum gilletii		f	C		x	f	f	f	

7. Afromontane single-dominant *Hagenia abyssinica* forest (Fd)

7.1. Description

Hagenia abyssinica is found on most of the higher mountains between Ethiopia and northern Malawi, including Mt. Kenya, Mt. Meru (Tanzania), the Nyika Plateau (Malawi) and the Virunga mountains (Rwanda). Characteristically, ***Hagenia abyssinica*** forms almost pure stands of 9 to 15 m tall in a narrow and often interrupted zone between the montane Ericaceous belt (E) and taller types of Afromontane rain forest (Fa) or Afromontane undifferentiated forest (Fbu). The best-developed stands are clearly forest, but other stands have a structure that is better described as woodland or scrub forest (White 1983 p. 166).

Some authors have suggested that Afromontane single-dominant ***Hagenia abyssinica*** forest is a climax vegetation type where low night temperatures exclude other trees. However, even at high altitudes the dominance of ***Hagenia abyssinica*** is probably still the result from disturbance. The altitudinal range of this species is between 1800 and 3400 m. The abundance of this species does not seem to be related to moisture conditions, although the species is usually absent from Afromontane rain forest (Fa) and taller types of Afromontane undifferentiated forest (White 1983 p. 166).

Figure 7.1. Afromontane single-dominant *Hagenia abyssinica* forest between the Karisimbi and Bisoke volcanoes in the Volcanoes National Park (Rwanda). Photograph by E. Fischer (October 1991)

Figure 7.2. Flowering Hagenia abyssinica tree against a background of Afromontane bamboo (*Sinarundinaria alpina*, synonym: *Arundinaria alpina*) n Kahuzi-Biega National Park (D.R.Congo). *Hagenia abyssinica* is also present in other types of Afromontane forest such as Afromontane single-dominant *Juniperus procera* forest (Fbj). Photograph by E. Fischer (October 1991).(Rwanda).

7.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 7. Species composition of Afromontane single-dominant *Hagenia abyssinica* forest (Fd)

SPECIES	Regional status	Ethiopia (FbuE subtype)	Kenya	Malawi	Rwanda	Tanzania	Uganda
Hagenia abyssinica	dominant	D	C	D	D	D	C
Hypericum revolutum	indicator species	f	C	f	C	f	x
Apodytes dimidiata	characteristic species	f	f	x	f	f	f
Ilex mitis	characteristic species	f	f	C	f	f	f
Kiggelaria africana	characteristic species (species that does not extend as far north as Ethiopia)			C		f	
Nuxia congesta	characteristic species	f	f	x	f	f	f
Nuxia floribunda	characteristic species		f	x	f	f	f
Podocarpus latifolius	characteristic species (species that does not extend as far north as Ethiopia)		f	C	f	f	f
Prunus africana	characteristic species	f	f	C	f	f	x
Rapanea melanophloeos	characteristic species	f	f	C	f	f	x
Xymalos monospora	characteristic species (species that does not extend as far north as Ethiopia)		f	x	f	f	f
Cassipourea malosana	not characteristic	f	f	C		f	f
Cornus volkensii			C	f	f	f	C
Cussonia spicata			f	C		f	f
Lepidotrichilia volkensii		f	C	x	f	f	f
Olea capensis	not characteristic	f	f	C	f	f	f
Olinia rochetiana		f	f	C	f	f	f
Pittosporum viridiflorum		f	f	C	f	f	f
Schefflera volkensii		f	C			f	f

8. Lake Victoria transitional rain forest (Ff)

8.1. Description

White describes two types of Lake Victoria transitional rain forest: (i) transitional rain forests occurring between 1600 and 1900 m in western Burundi, western Rwanda and eastern Kivu (DRC); and (ii) Kakamega forest in Kenya (1520 to 1680 m). Kakamega forest is described as containing a mixture of Guineo-Congolian lowland rain forest species (that reach their easternmost limits in distribution in Kakamega forest) and Afromontane species, but containing fewer Afromontane species than the other Lake Victoria transitional rain forests (White 1983 p. 181).

Regional indicator species (characteristic species listed by White (1983) [1983] that were only provided for Lake Victoria transitional rain forest and no other Lake Victoria forest types) that were listed as characteristic species for one or several national maps include ***Alangium chinense*** (Afromontane species, also a indicator for Zanzibar-Inhambane transitional rain forest [Ff]), ***Anthonotha pynaertii, Apodytes dimidiata*** (Afromontane species, also characteristic of Afromontane undifferentiated forest [Fbu] and Afromontane dry transitional forest [Fh]), ***Carapa procera, Chrysophyllum gorungosanum*** (also a indicator of Afromontane rain forest [Fa]), ***Cordia millenii*** (Guineo-Congolian lowland rain forest species), ***Diospyros gabunensis, Macaranga capensis*** (synonym: *Macaranga kilimandscharica; Afromontane species),* ***Monodora myristica*** (Guineo-Congolian lowland rain forest species), ***Neoboutonia macrocalyx*** (Afromontane species), ***Newtonia buchananii*** (also a characteristic species of Afromontane moist transitional forest [FeK], Afromontane dry transitional forest [Fh; near streams], Zanzibar-Inhambane lowland rain forest [Fo] and Zanzibar-Inhambane transitional rain forest [Fg; upland species]), ***Parinari excelsa*** (also an indicator of Afromontane rain forest [Fa]), ***Prunus africana*** (Afromontane species, also characteristic of Afromontane rain forest [Fa] and Afromontane undifferentiated forest [Fbu]), ***Strombosia scheffleri*** (Afromontane species, also a indicator of Afromontane rain forest [Fa]), ***Symphonia globulifera, Syzygium guineense*** (also an indicator of Afromontane rain forest [Fa]), ***Turraea holstii*** (Afromontane species) and ***Xymalos monospora*** (also characteristic of Afromontane rain forest [Fa] and Afromontane undifferentiated forest [Fbu]).

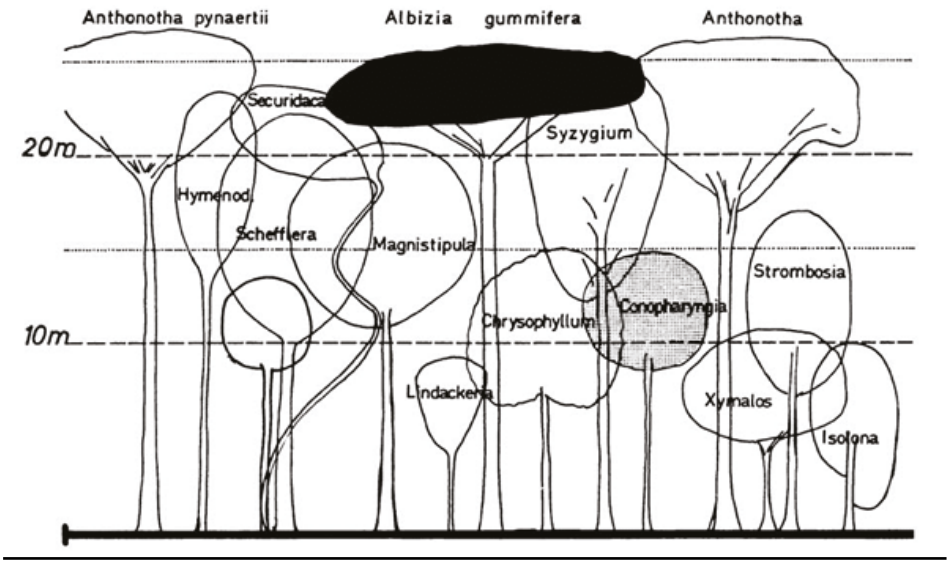


Figure 8.1. Profile diagram of Lake Victoria transitional rain forest in Burundi. Although White (1983 p. 164) listed this profile diagram for the description of Afromontane rain forest (Fa), the altitude range for this forest type of 1600 – 1900 m were described by White (1983 p. 181) for Lake Victoria transitional rain forest (Ff) and also corresponded to the altitude range of the "horizon inférieur" mentioned with the original publication of this profile diagram, Lewalle (1972, Fig. 21). Figure obtained from URL: *http://www.jstor.org/stable/3667406*.

Figure 8.2. Lake Victoria transitional rain forest in South Nandi forest. Photograph by F. Gachathi.

8.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 8. Species composition of Lake Victoria transitional rain forest (Ff)

SPECIES	Regional status	Kenya	Rwanda
Alangium chinense	indicator species (Afromontane species)	x	f
Anthonotha pynaertii	indicator species		x
Apodytes dimidiata	indicator species (Afromontane species)	x	x
Carapa procera	indicator species		C
Chrysophyllum gorungosanum	indicator species (Afromontane species)	f	C
Cordia millenii	indicator species (Guineo-Congolian species)	C	
Diospyros gabunensis	indicator species		x
Macaranga capensis	indicator species (Afromontane species)	x	x
Monodora myristica	indicator species (Guineo-Congolian species)	C	
Neoboutonia macrocalyx	indicator species (Afromontane species)	C	C
Newtonia buchananii	indicator species	f	C
Parinari excelsa	indicator species (Afromontane species)		C
Prunus africana	indicator species (Afromontane species)	x	x
Strombosia scheffleri	indicator species (Afromontane species)	C	x
Symphonia globulifera	indicator species		C
Syzygium guineense	indicator species (Afromontane species [*Syzygium guineense* ssp. *afromontanum*])	x	x
Turraea holstii	indicator species (Afromontane species)	C	
Xymalos monospora	indicator species (Afromontane species)	x	x
Albizia gummifera	characteristic species	C	C
Entandrophragma angolense	characteristic species (Guineo-Congolian species)	C	
Maesopsis eminii	characteristic species (Guineo-Congolian species)	C	f
Pouteria altissima	characteristic species (Guineo-Congolian species)	C	x
Acacia abyssinica		x	f
Acacia lahai		x	
Acacia mearnsii		f	x
Agauria salicifolia		f	x
Albizia grandibracteata		C	f
Albizia zygia		C	
Alchornea hirtella		x	x
Allophylus abyssinicus		x	x
Allophylus rubifolius		x	f
Anthocleista grandiflora		C	
Antiaris toxicaria	not characteristic	C	f
Antidesma venosum		x	
Beilschmiedia ugandensis		x	
Bersama abyssinica		C	f
Blighia unijugata		C	f
Bridelia brideliifolia			x
Bridelia micrantha		C	f
Buddleja polystachya		x	
Caesalpinia decapetala		x	f
Caesalpinia volkensii		x	
Casearia battiscombei		C	
Cassipourea malosana		C	
Cassipourea ruwensoriensis		C	x
Celtis africana		x	f
Celtis gomphophylla		C	C
Celtis mildbraedii		C	
Chrysophyllum albidum	not characteristic	C	
Clausena anisata		x	C
Cordia africana		C	f
Craibia brownii		x	f
Crotalaria agatiflora		x	f
Croton macrostachyus		C	x
Croton megalocarpus		C	x
Croton sylvaticus		C	
Cyathea manniana		x	x
Diospyros abyssinica		C	f
Dombeya torrida		x	x
Dovyalis abyssinica		x	
Dovyalis macrocalyx		x	x
Dracaena fragrans		x	f
Dracaena steudneri		C	x

SPECIES	Regional status	Kenya	Rwanda
Ehretia cymosa		C	C
Ekebergia capensis		C	x
Embelia schimperi		x	x
Ensete ventricosum		f	x
Entada abyssinica		x	f
Entandrophragma excelsum			C
Eugenia capensis		f	x
Fagaropsis angolensis		C	x
Ficalhoa laurifolia			x
Ficus exasperata		C	x
Ficus natalensis		x	f
Ficus sur		C	x
Ficus thonningii		C	f
Funtumia africana		C	
Galiniera saxifraga		x	x
Garcinia buchananii		C	f
Hagenia abyssinica		x	x
Harungana madagascariensis		C	C
Hypericum revolutum		f	x
Ilex mitis		f	x
Kigelia africana		f	x
Kigelia moosa		C	
Lecaniodiscus fraxinifolius		C	
Lepidotrichilia volkensii		x	x
Lovoa trichilioides			x
Maesa lanceolata		x	x
Manilkara butugii		C	
Margaritaria discoidea		x	
Markhamia lutea		C	f
Maytenus acuminata		f	x
Maytenus undata		x	x
Milicia excelsa	not characteristic	C	f
Mimusops bagshawei		C	f
Mimusops kummel		C	
Mondia whitei		x	
Morus mesozygia	not characteristic	C	
Nuxia congesta		C	x
Nuxia floribunda		f	x
Ocotea kenyensis		f	x
Ocotea usambarensis		f	x
Olea capensis		C	f
Olinia rochetiana		f	x
Peddiea fischeri		f	x
Phoenix reclinata	(palm species)	x	f
Phytolacca dodecandra		x	f
Pittosporum viridiflorum		x	x
Plectranthus barbatus		x	
Pleiocarpa pycnantha		f	x
Podocarpus falcatus		f	x
Podocarpus latifolius		f	x
Polyscias fulva		C	x
Pouteria adolfi-friedericii		x	f
Pseudospondias microcarpa		C	x
Psychotria mahonii		x	x
Psydrax parviflora		C	f
Pterolobium stellatum		x	f
Rapanea melanophloeos		x	x
Rhamnus prinoides		x	x
Rinorea angustifolia		f	x
Ritchiea albersii		x	x
Rothmannia urcelliformis		C	
Rubus apetalus		x	x
Rubus volkensii		x	

SPECIES	Regional status	Kenya	Rwanda
Schefflera abyssinica		x	
Schefflera volkensii		x	
Schrebera alata		fh	x
Scutia myrtina		x	f
Senna didymobotrya		x	f
Senna septemtrionalis		x	f
Shirakiopsis elliptica		C	C
Smilax anceps		f	x
Solanum aculeastrum		x	x
Spathodea campanulata		C	f
Sterculia dawei		x	
Tabernaemontana pachysiphon		C	
Tabernaemontana stapfiana		x	x
Trema orientalis		C	x
Trichilia dregeana		C	
Trichilia emetica		C	
Trilepisium madagascariense		C	
Vangueria apiculata		f	x
Vepris nobilis		C	x
Vernonia amygdalina		x	f
Vernonia auriculifera		x	f
Vernonia myriantha		x	x
Warburgia ugandensis		C	
Zanthoxylum gilletii		C	x
Zanthoxylum rubescens		C	

9. Lake Victoria Euphorbia dawei scrub forest (edaphic forest type, fe)

9.1. Description

Vegetation intermediate between rain forest and evergreen bushland (Be) probably occurred more extensively in the Lake Victoria basin than in other parts of Africa, but only few relicts remain (White 1983 p. 182).

White (1983 p. 182) describes the following types of Lake Victoria scrub forests: (i) *Cynometra-Euphorbia* scrub forest in Burundi and Uganda; (ii) ***Euphorbia dawei*** scrub forest in the basin of Lake Edward; (iii) ***Euphorbia dawei*** scrub forest in the Ruzizi valley and (iv) tall scrub forest in the Ruzizi valley (White 1983 p. 182):

- *Cynometra-Euphorbia* scrub forest in Burundi and Uganda is characterized by 10 m tall ***Cynometra alexandri*** (also a characteristic species of Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest [Fi]) and is usually associated with ***Euphorbia dawei***.
- ***Euphorbia dawei*** scrub forest in the basin of Lake Edward (0º 21' S; 29º 37' E) forms forests have canopies of 12 to 15 m; they occur at 900 to 1000 m altitude in bands up to 3 km wide along the banks of rivers and on the lower slopes of escarpments.
- ***Euphorbia dawei*** forms scrub forests only in a single locality in the Ruzizi valley where ***Euphorbia dawei*** occurs as a 17 to 18 m high emergent above a 10 to 12 m canopy of ***Cynometra alexandri*** and *Tamarindus indica*. This formation is described as the Burundian 'La forêt sclérophylle à ***Euphorbia dawei***' forest type by Lewalle (1972 p. 57, see below).
- Tall scrub forest of 15 m high is expected to be the climax community in the Ruzizi valley and consists of an upper canopy of ***Albizia grandibracteata***, *Euphorbia candelabrum*, *Grewia mollis*, ***Strychnos potatorum*** and *Tamarindus indica*. This formation is described as the 'La forêt sclérophylle à *Strychnos potatorum*' forest type by Lewalle (1972 p. 57) and as 'La forêt tropophile à ***Albizia grandibracteata*** et ***Strychnos potatorum*** ' forest type by Germain (1955 p. 41).

We classified *Euphorbia dawei* scrub forest as an edaphic vegetation type based on the suggestion that this vegetation type is especially restricted to rocky slopes, whereas evergreen bushland (Be) would be the climax vegetation type elsewhere (White 1983 p. 183).

Besides the potentially dominant ***Cynometra alexandri*** and ***Euphorbia dawei***, regional indicator species (characteristic species listed by White (1983) that were only provided for Lake Victoria ***Euphorbia dawei*** scrub forest and no other Lake Victoria forest types, include ***Cissus quadrangu-***

laris (liana species), [***Olea europaea*** subsp. ***cuspidata*****,** (synonym: ***Olea africana***; also a indicator for Afromontane dry transitional forest [Fh]) and ***Psydrax parviflora***.

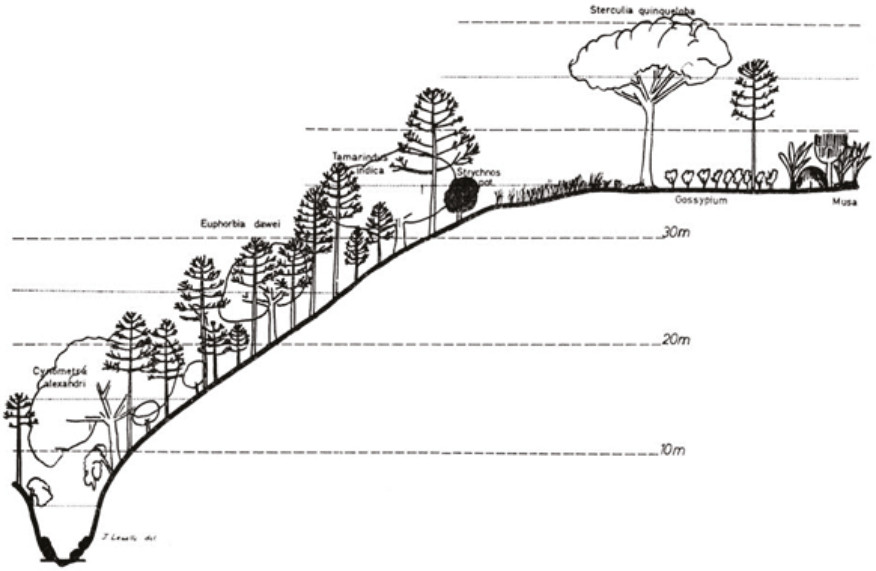


Figure 9.1. Profile diagram of Lake Victoria *Euphorbia dawei* scrub forest in Burundi. Lewalle (1972, Fig.15). Image obtained from URL: http://www.jstor.org/stale/3667406

9.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 9. Species composition of Lake Victoria *Euphorbia dawei* ***s***crub forest (edaphic forest type, fe)

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda (fsbU subtype)	Uganda (fsrU subtype)	Zambia	Coast
Acacia kirkii	Lake Victoria swamp forest		f		f	f	f	C	f	
Acrostichum aureum	Zanzibari-Inhambane swamp forest (fern species)					f				x
Albizia glaberrima	Somalia-Masai riparian forest		f	f		f	x	f	f	f
Alchornea hirtella			f	f	f	f	x	f	x	
Anthocleista grandiflora			C	x		f	f	f		x
Anthocleista schweinfurthii	Lake Victoria swamp forest	f			f	f	x	f	C	
Antidesma venosum		C	f	f		f	f	f	f	f
Apodytes dimidiata	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f	f	f	x	f	f	f
Aporrhiza nitida	Zambezian swamp forest			f					x	
Baikiaea insignis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river (dominant)				f	f	D	f		
Barringtonia racemosa	Zanzibar-Inhambane swamp forest, also mangrove associated species		f			f				x
Beilschmiedia ugandensis			f			f	x	f	C	
Blighia unijugata		f	f	f	C	f	x	C	f	f
Bridelia micrantha		f	f	f	f	f	x	f	x	f
Canarium schweinfurthii	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river	f				f	x	f	f	
Celtis africana		f		f	C	f	f	f	f	f
Celtis gomphophylla		f	f	f	f	C	f	C	f	f
Clausena anisata		f	f	f	f	f	x	f	x	f
Combretum imberbe	Zambezian deciduous riparian forest			f		f			f	f
Cordia africana		f	f	f	C	f	x	f	f	
Cordyla africana	Zambezian deciduous riparian forest		C			C			f	f
Craterispermum laurinum	Zambezian swamp forest		f						x	
Croton megalocarpus	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river		f	f	f	f	x	f	f	
Diospyros mespiliformis	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	f	C	f		f	f	f	f	f
Dombeya rotundifolia		f	f	f	C		f	f	f	
Dracaena camerooniana	Zambezian swamp forest								x	
Ekebergia capensis	riparian forest in the greater Serengeti region	f	f	f	C	f	x	f	x	f
Elaeis guineensis	Zanzibar-Inhambane swamp forest (palm species)		f	f		f	f	f		x
Erythrina abyssinica		f	f	f	x	f	x	f	f	f
Erythrina excelsa	Lake Victoria swamp forest		f			f	x	f	f	
Erythrophleum suaveolens	Zambezian evergreen or semi-evergreen riparian forest		f	f		C	f	f	f	f
Erythroxylum fischeri			C			f	x	f		
Euclea divinorum		f	f	f	C	f	f	f	f	f
Faidherbia albida		f	C	f	f	f	f	f	f	f
Ficalhoa laurifolia				f	f	f	f	f	C	
Ficus natalensis			C	f	f	f	x	f	f	f
Ficus sur	Zambezian deciduous riparian forest	f	C	f	f	f	x	f	C	x
Ficus sycomorus	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	f	x	f	x	f	x	f	f	x
Ficus trichopoda	Lake Victoria swamp forest; Zambezian swamp forest			x	C	f	f	f	C	
Ficus vallis-choudae		f	f	f	C	f	f	f	f	f
Flueggea virosa		f	f	f	f	f	x	x	f	f
Funtumia africana			C	f		f	x	f		f
Garcinia smeathmannii	Zambezian swamp forest			f		f			x	
Gardenia imperialis	Zambezian swamp forest			f		f	f	f	x	
Hallea stipulosa	Lake Victoria swamp forest; Zambezian swamp forest			x		x	f	f	C	
Hibiscus tiliaceus	Zanzibar-Inhambane swamp forest, also mangrove associated species		x			f				x
Ilex mitis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river; Zambezian swamp forest	f	f	f	f	f	C	f	C	
Khaya anthotheca	Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest		f	f		C	f	f	f	f
Kigelia africana	Somalia-Masai and Zambezian deciduous riparian forest		f	f	f	f	x	C	f	f
Klainedoxa gabonensis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river					f	x	f	f	
Lannea schweinfurthii			f	f	C	f	f	f	f	f
Lecaniodiscus fraxinifolius	Somalia-Masai (including greater Serengeti region) and Zambezian deciduous riparian forest		f	f		f	x	f	f	f
Macaranga monandra	Lake Victoria swamp forest					f	x	f		
Macaranga schweinfurthii	Lake Victoria swamp forest		C		x	f	x	f	f	
Macaranga spinosa	Lake Victoria swamp forest					C				
Maesa lanceolata		f	f	f	f	f	x	f	x	
Maesopsis eminii	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		f		f	f	x	f	f	
Musanga cecropioides	Lake Victoria swamp forest					x	f	f		
Newtonia buchananii	Zambezian evergreen or semi-evergreen riparian forest; near streams in Afromontane dry transitional forest		C	f	f	f	f	f	f	f
Parinari excelsa				f	f	f	x	f	C	f

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda (fsbU subtype)	Uganda (fsrU subtype)	Zambia	Coast
Parkia filicoidea	Lake Victoria swamp forest (also Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest)		C	f		f	x	f	f	f
Peddiea fischeri			f		f	f	x	f	x	
Phoenix reclinata	Lake Victoria swamp forest; Zanzibar-Inhambane swamp forest; palm species	C	f	x	f	f	f	C	x	x
Podocarpus falcatus	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f	f	f	f	f		
Podocarpus latifolius	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river		f	f	x	f	D	f	f	
Podocarpus usambarensis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river (dominant [*Podocarpus usambarensis* var. *dawei*])		f			f	D	f		
Pseudospondias microcarpa	Lake Victoria swamp forest; Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		C		f	f	x	f	f	
Psychotria mahonii			C	f	f	f	x	f	f	
Psychotria peduncularis	Zambezian swamp forest		f	f	x	f	f	f	x	
Pterocarpus tinctorius				f		C			f	f
Pycnanthus angolensis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river					f	x	f	f	
Raphia farinifera	Lake Victoria swamp forest (palm species)		C	x		f	x	f	C	x
Rauvolfia caffra			f	f		f	x	D	C	f
Ritchiea albersii		f	f		C	f	x	f	f	
Rothmannia urcelliformis		f	f	f		f	x	x	f	
Schrebera arborea							x	C		
Scutia myrtina		f	f	f	C	f	x	f	x	
Shirakiopsis elliptica		f	f	f	C	f	x	f	C	
Sorindeia madagascariensis			C	f		f				x
Spondianthus preussii	Lake Victoria swamp forest					f	C	f		
Sterculia tragacantha					f	f			C	
Strombosia scheffleri	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river		f	f	f	f	x	f		f
Strychnos mitis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f		f	x	f		f
Symphonia globulifera	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river				f	f	x	f	f	
Syzygium cordatum	Lake Victoria swamp forest; Zambezian swamp forest		f	D	C	f	f	x	C	f
Syzygium guineense	Sudanian riparian forest (*Syzygium guineense* ssp. *guineense*)	C	f	f	x	f	x	f	f	f
Syzygium owariense	Zambezian swamp forest			D		f	f	f	C	
Terminalia sambesiaca	Somalia-Masai riparian forest		f	f		C			f	f
Tetrapleura tetraptera	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		f				x	f		f
Trichocladus ellipticus	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f	f	f	x	f	f	
Typhonodorum lindleyanum	Zanzibar-Inhambane swamp forest					f				x
Uapaca guineensis	Lake Victoria swamp forest; Zambezian swamp forest			f		f			C	f
Vangueria madagascariensis		f	C	f		f	f	f		f
Vepris nobilis		f	f	f	C	f	x	f	f	f
Vitex doniana	Sudanian riparian forest	f	f	f	f	f	f	f	f	x
Voacanga thouarsii	Lake Victoria swamp forest; Zanzibar-Inhambane swamp forest		C	f		x	f	f	x	x
Warburgia ugandensis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f		f	x	f		
Xylopia aethiopica	Zambezian swamp forest		f			f	x	f	C	f
Xylopia rubescens	Zambezian swamp forest					f	f	f	C	
Ziziphus pubescens		f	C	f		f	f	f	f	f

10. Riverine forests (edaphic forest type, fr)

10.1. Description

Although White (1983) treated riverine forests separately within the descriptions of regional centres of endemism, we decided not to map floristic variants of riverine forests. Actually, it was in most situations not practical to map riverine forests.

Zambezian riparian forest can be further classified in: (i) evergreen or semi-evergreen riparian forest; and (ii) deciduous riparian forest. Evergreen or semi-evergreen riparian forest of 20 m (or taller) occurs on fringes or perennial streams in areas where annual rainfall exceeds 1000 mm. Riparian forest where most of the tree species are deciduous for at least two months are confined to the banks of major watercourses in areas where annual rainfall is less than 800 mm. The latter riparian forest type has probably always been kept open by movements and browsing of large mammals, which explains the presence of heliophilous ('sun-loving') species of *Acacia* and other genera (White 1983 p. 91). Evergreen riparian forests are among the associated vegetation types that characterize wetter miombo woodland (Wn), whereas deciduous riparian forests are among the associated vegetation types that characterize drier miombo woodland (White 1983 p. 93).

Sudanian riparian forest was further classified in: (i) semi-evergreen riparian forest; and (ii) semi-deciduous riparian forest. The former occurs in the southern (wetter) half of the Sudanian region, whereas the latter occurs in the northern (drier) half of the Sudanian region where it is often degraded to riparian woodland (White 1983 p. 105).

Somalia-Masai riparian forest occurs only on the banks of larger rivers such as the Galana, Kiboko, Tana, Uaso Nyiro and Voi rivers of Kenya (riparian forests also occur in Tanzania; White 1983 p. 117).

Since we think that the riverine occurrence of riverine forests is more characteristic than the species composition of these forests, we refer to section 20.3 for information about characteristic species.

10.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Figure 10.1. Riverine forest at Rusumo along Akagera River (Rwanda). Photograph by E. Fischer (October 1985).

Figure 10.2. Riverine forest dominated by *Cynometra* and *Baphia* species along the Mpanga River Gorge (Kamwenge, Uganda). Photograph by J. Kalema (January 2009).

Table 10. Species composition of Riverine forests (edaphic forest type, fr)

SPECIES	Regional status	Ethiopia	Kenya (forest subtype)	K enya (woodland subtype)	Malawi	Rwanda	Tanzania	Uganda	Zambia	Coast
Acacia asak		x								
Acacia elatior	Somalia-Masai riparian forest		C	C				f		C
Acacia galpinii	Zambezian deciduous riparian forest				C				f	
Acacia gerrardii		f	C		f	f	f	x	f	f
Acacia kirkii	Lake Victoria swamp forest		C			x	f	f	f	
Acacia nigrescens					f		f		C	
Acacia oerfota		f	x				f	C		f
Acacia polyacantha	Zambezian deciduous riparian forest	C	C		x	f	f	f	f	f
Acacia robusta	Somalia-Masai and Zambezian deciduous riparian forest	x	C	f			f		f	C
Acacia seyal		f	x	C	f		f	f	f	
Acacia sieberiana	Sudanian riparian forest	f	C		x	f	f	f	f	f
Acacia tortilis	Zambezian deciduous riparian forest, along larger seasonal streams in Marsabit district	f	C	C			f	C	f	f
Acacia xanthophloea	Zambezian deciduous riparian forest		C		x		f			f
Acokanthera oppositifolia			C		f				f	f
Afzelia quanzensis			f		x		f	f	f	C
Albizia glaberrima	Somalia-Masai riparian forest		C	f	x		C	f	x	f
Albizia grandibracteata		x	C			f	f	f		
Albizia petersiana			C		x	f	f	f		f
Albizia saman	(exotic species)		C							f
Albizia schimperiana		f	C		f		f	f	f	
Albizia versicolor	Zambezian deciduous riparian forest		f		x	f	f	f	f	x
Albizia zimmermannii	Somalia-Masai riparian forest		C	f	x		f		f	
Albizia zygia			C				f	f		
Allophylus abyssinicus		x	C		x	f	f	f	f	
Allophylus africanus		x	x		x	x	f	f	x	
Allophylus rubifolius		f	C		f	f	f	f	f	f
Annona senegalensis		f	C		x	f	f	f	f	f
Anthocleista grandiflora			C		x		f	f		C
Antiaris toxicaria		f	f			f	f	f	f	C
Antidesma venosum		x	C		f		f	f	x	C
Aphania senegalensis	riparian forest in the greater Serengeti region	C	C				f	f		C
Apodytes dimidiata	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	x	f		x	x	f	f	C	f
Baikiaea insignis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river (dominant)					x	f	f		
Balanites aegyptiaca		f	C			f	f	f	f	
Balanites wilsoniana			f				f	f		C
Berchemia discolor		x	C		x		f	f	f	f
Bersama abyssinica		x	C		f	x	f	f	f	f
Blighia unijugata		x	C		f	x	f	f	f	f
Bombax rhodognaphalon			f		x		f			C
Borassus aethiopum	(palm species)	f	C		D		f	f	f	f
Breonadia salicina	Sudanian and Zambezian evergreen or semi-evergreen riparian forest	C	x		C		f	f	C	C
Bridelia brideliifolia					x	x	x	x		
Bridelia micrantha		x	C		x	C	f	f	C	C
Burttdavya nyasica					C		f			C
Cadaba farinosa		f	C	C		f	f	f		f
Caesalpinia volkensii			C				f	f		f
Calodendrum capense			C		x		f	f		
Calotropis procera		x	C				f	f		f
Capparis tomentosa		x	C		x	f	f	x	x	f
Carissa spinarum		x	x		f	f	f	x	f	f
Celtis africana		C	C		f	f	f	f	f	x
Clausena anisata		f	C		x	x	f	f	x	f
Combretum imberbe	Zambezian deciduous riparian forest				x		f		f	f
Cordia africana		f	C		x	x	f	f	f	
Cordia monoica		x	C				f	f		f
Cordia sinensis		x	C	C			f	f	f	f
Cordyla africana	Zambezian deciduous riparian forest		f		C		f		f	f
Craibia brownii			C			f	f	f		f
Crateva adansonii		x	C				f	f		
Crotalaria agatiflora		f	C		f	f	f	f		
Croton macrostachyus		f	C		f	x	f	f	f	
Croton megalocarpus			C		f		f	f	f	
Cussonia spicata			C		f		f	f	f	
Delonix elata		f	f	C			f	C	f	
Diospyros abyssinica		x	C		f	f	f	f	f	x
Diospyros mespiliformis	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	C	C	f	C		C	f	C	C
Diospyros scabra		x	x	C				f		
Dobera glabra	Somalia-Masai riparian forest	f	x	f				f		f
Dombeya buettneri		f				x				
Dombeya kirkii		f	C		x	x	f	f	f	
Dovyalis abyssinica		x	C		f		f	f		
Dovyalis macrocalyx			C		x	x	f	f	f	f
Dracaena steudneri		f	f		x	x	f	f	f	
Ehretia cymosa		x	f		f	x		f		
Ekebergia capensis	riparian forest in the greater Serengeti region	f	C		x	x	f	f	x	f
Elaeodendron buchananii		f	C		x	f	f	f		
Embelia schimperi		x	f		x	x	f	f	x	
Ensete ventricosum		x	f		x	x	f	f	f	
Entada abyssinica		f	C		f	f	f	f	f	
Erythrina excelsa			C				f	f	f	

SPECIES	Regional status	Ethiopia	Kenya (forest subtype)	K enya (woodland subtype)	Malawi	Rwanda	Tanzania	Uganda	Zambia	Coast
Erythrophleum suaveolens	Zambezian evergreen or semi-evergreen riparian forest		f		C		f	f	C	C
Erythroxylum fischeri		x	C				f	f		
Euclea divinorum		f	C		x	f	f	f	x	f
Euclea natalensis			C		x		f		f	f
Euclea racemosa		f	f		x	x	f	C	f	f
Eugenia capensis		x	f		f	x	f	f	f	
Faidherbia albida	Zambezian deciduous riparian forest	f	C	C	x		f	x	C	f
Faurea saligna			f		x	f	f	f	C	f
Fernandoa magnifica	Somalia-Masai riparian forest (near coast and endemic to coastal forests)		f				x			f
Ficus exasperata		x	f		x	f	f	f	f	f
Ficus ingens	Somalia-Masai riparian forest	f	C	f	f	x	f	f	f	f
Ficus natalensis			C		f	f	f	f	f	f
Ficus ovata		x	C		f	f	f	f	f	
Ficus sur	Zambezian deciduous riparian forest	x	C		x	f	f	f	C	x
Ficus sycomorus	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	C	C	f	x	C	C	f	f	C
Ficus thonningii		x	C		f	x	f	f	f	
Ficus vallis-choudae		x	C		x	x	f	f	f	x
Ficus vasta		x	C				f	x	f	
Filicium decipiens		x	C		x		f			
Flacourtia indica		x	f		x	f	f	f	x	f
Flueggea virosa		f	C		f	f	f	f	f	f
Garcinia livingstonei	Somalia-Masai riparian forest (including greater Serengeti region)	x	C	f	x		f	f	C	C
Gardenia ternifolia		f	C			f	f	f		f
Gardenia volkensii		x	C				f	f	x	f
Grewia villosa		f	f	C			f	f		f
Harrisonia abyssinica		f	C		x	f	f	f	f	C
Hymenaea verrucosa			f				f			C
Hypericum quartinianum		f	C		f		f	f	f	
Hyphaene compressa	(palm species)	f	C	C			f			C
Hyphaene coriacea	(palm species)		f	C			f			f
Hyphaene petersiana	(palm species)				x		f		C	
Ilex mitis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river; Zambezian swamp forest	x	C		x	f	f	f	C	
Jatropha curcas			C		f		f	f	f	f
Justicia schimperiana		x	x				f			f
Khaya anthotheca	Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest		x	f	C		C	f	C	C
Kigelia africana	Somalia-Masai and Zambezian deciduous riparian forest	x	C	f	x	C	C	x	f	C
Kigelia moosa			C				f	f		
Landolphia buchananii		x	C		f		f	f	x	
Lannea schweinfurthii		f	x		x	f	f	f	f	f
Lawsonia inermis		f	C	x			f	f		C
Lecaniodiscus fraxinifolius	Somalia-Masai (including greater Serengeti region) and Zambezian deciduous riparian forest	x	C	f	x		f	f	f	C
Leptadenia hastata		f	C							
Maerua decumbens		f	C				f	f		f
Maesa lanceolata		x	f		x	x	f	f	x	
Maesopsis eminii	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		C		f	f	f	f	f	
Manilkara mochisia	Zambezian deciduous riparian forest		f		x		f		C	f
Markhamia lutea			C			x	f	f		
Maytenus arbutifolia		f	C			f	f	f		
Maytenus senegalensis		f	C		f	f	f	f	x	f
Milicia excelsa		f	f		C	f	f	f		C
Mimusops bagshawei			C			x	f	f		f
Mimusops kummel		C	C		f		f	f		
Mimusops obtusifolia			f		x		f			C
Mimusops zeyheri	Zambezian deciduous riparian forest				f		f		C	
Monodora myristica			C				f	f		
Monopetalanthus richardsiae	Zambezian evergreen or semi-evergreen riparian forest						f		x	
Moringa stenopetala		f	f					C		
Mussaenda arcuata		x	f				f	f		
Myrianthus holstii			C		f	f	f	f	f	f
Newtonia buchananii	Zambezian evergreen or semi-evergreen riparian forest; near streams in Afromontane dry transitional forest		C		C	x	f	f	f	C
Newtonia hildebrandtii	Somalia-Masai and Zambezian deciduous riparian forest		C	f	x		f		f	
Oncoba spinosa		x	C		x		f	f	x	
Oreobambos buchwaldii	(bamboo species indigenous to Africa)		C		x		f	f	f	
Oxystigma msoo			C				f			x
Parinari excelsa					x	f	f	f	C	C
Parkia filicoidea	Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest (Lake Victoria swamp forest)		x	f	C		C	f	f	C
Parkinsonia aculeata			C							
Pavetta oliveriana		x	C			x	f	f		
Phoenix dactylifera			x				f			f
Phoenix reclinata	Lake Victoria swamp forest; Zanzibar-Inhambane swamp forest; palm species	C	C		x	x	f	f	x	C
Phytolacca dodecandra		f	C		f	x	f	f	f	
Piliostigma thonningii		f	f		x	f	f	f	f	C
Pittosporum viridiflorum		f	C		x	x	f	f	f	
Polyscias fulva			C		f	f	f	f	f	
Populus ilicifolia	Somalia-Masai riparian forest		C	f			f			C
Premna schimperi		x					f	f		
Prunus africana		f	C		x	f	f	f	f	

SPECIES	Regional status	Ethiopia	Kenya (forest subtype)	K enya (woodland subtype)	Malawi	Rwanda	Tanzania	Uganda	Zambia	Coast
Pseudospondias microcarpa	Lake Victoria swamp forest; Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		C			x	f	f	f	
Psychotria mahonii			C		x	f	f	f	f	
Pterocarpus tinctorius					x		f		f	C
Raphia farinifera	Lake Victoria swamp forest (palm species)		C		x		f	f	C	f
Rauvolfia caffra			C		f		f	f	x	f
Rhoicissus revoilii		x	C		f	f	f	f	f	f
Rhus longipes		x	C		f	f	f	f	x	f
Ritchiea albersii		f	C			x	f	f	f	
Rothmannia urcelliformis		x	C		f		f	f	f	
Saba comorensis		x	C		x					
Salvadora persica		x	C	C	f		f	f	f	f
Sclerocarya birrea		f	C		f		f	f	f	f
Scutia myrtina		x	C		f	x	f	f	x	
Senna didymobotrya		f	C		f	f	f	f	f	
Senna septemtrionalis			C		f	f	f	f	f	
Sesbania macrantha			C		f	f	f	f	f	
Sesbania sesban		x	C		x	f	f	f	f	x
Shirakiopsis elliptica		x	C		C	x	f	f	x	
Sideroxylon inerme			C				f			f
Smilax anceps		f	C			f	f	f	x	
Solanecio mannii		x	C		f	f	f	f	x	
Solanum aculeastrum			C		f	f	f	f		
Sorindeia madagascariensis			C		C		f			C
Spathodea campanulata			C			x	f	f		
Spirostachys venenifera			C				f			C
Steganotaenia araliacea		f	C		f	f	f	f	f	
Sterculia appendiculata			C		C		f			C
Strychnos henningsii		f	C		x		f	f	f	x
Strychnos mitis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	x	C		f		f	f		f
Strychnos potatorum	Zambezian deciduous riparian forest				x	f			C	
Strychnos spinosa		x	f		x	f	f	f	f	f
Suregada procera		f	C		f		f	f	f	
Synsepalum brevipes			C		x		f	f	x	C
Syzygium cordatum	Lake Victoria swamp forest; Zambezian swamp forest		C		x	f	f	f	C	f
Syzygium guineense	Sudanian riparian forest (*Syzygium guineense* ssp. *guineense*)	C	C		C	x	f	f	C	C
Syzygium owariense	Zambezian swamp forest				C		f	f	f	
Tamarindus indica	Somalia-Masai and Sudanian riparian forest	C	C	C	x		C	f	x	f
Tamarix aphylla		x	x							
Tamarix nilotica		C	C				f			
Tarenna graveolens		f	C			f	f	f		
Terminalia brownii		f	C				f	x		f
Terminalia prunioides		f	C				f		f	f
Terminalia sambesiaca	Somalia-Masai riparian forest		x	f	C		f		f	C
Tetradenia riparia		x	f			f			x	
Trema orientalis		x	C		f	C	f	f	x	f
Trichilia dregeana			C		f		f	f	f	f
Trichilia emetica	Somalia-Masai and Zambezian deciduous riparian forest	C	C	f	C		C	f	C	C
Uvaria scheffleri			C				f	f		f
Vangueria apiculata		x	C		f	f	f	f	f	
Vangueria infausta			C		f	f	f	f	f	f
Vangueria madagascariensis		f	C		f		f	f		f
Vepris nobilis		x	C		f	x	f	f	f	f
Vernonia amygdalina		x	C		x	x	f	f	f	
Vernonia myriantha		x	f		x	f	f	f	f	
Vitex doniana	Sudanian riparian forest	f	f		x	f	f	f	x	f
Warburgia ugandensis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	C		f		f	f		
Woodfordia uniflora		x	C					f		
Xanthocercis zambesiaca	Zambezian deciduous riparian forest				x				f	
Xylopia parviflora		f	f		x		f	f	f	C
Zanha golungensis		x	f		f	x	f	f	f	f
Zanthoxylum gilletii		x	f			x	f	f		
Ziziphus abyssinica		f	f		x	f	f	x	f	f
Ziziphus mauritiana		x	C		f		f	f	x	f
Ziziphus mucronata		x	C		f	f	f	x	x	f
Ziziphus pubescens		x	C		x		f	f	f	f
Ziziphus spina-christi		f	C				f	f		f

11. Swamp forest (edaphic forest type, fs)

11.1. Description

In analogy with riverine forests (fr), we decided not to map floristic variants of riverine forests although White (1983) treated riverine forests separately within the descriptions of regional centres of endemism. Actually, it was in most situations not practical to map swamp forests.

In the wetter parts of the Zambezian region (with rainfall above 1000 mm), permanent swamp forest occurs around springs at the sources of tributary streams. Swamp forests also occurs along watercourses (*i.e.* also as subtype of riverine forest [fr]) where water movement is locally sluggish. In the latter situation, swamp forests merge into other types of riparian forest in which the water table is at some distance below the surface for at least part of the year (White 1983 p. 91).

Although White (1983) lists a heading within the description of the Sudanian region as "Sudanian swamp forest and riparian forest", he does not give a specific description of Sudanian swamp forest (White 1983 pp. 103 - 104).

Swamp forests dominated by species that are widespread in tropical Africa occur extensively on the shores of Lake Victoria and elsewhere in the Lake Victoria region. On alluvial deposits of the Kagera river (on the western shore of Lake Victoria), a unique swamp forest occurs that is composed almost in equal proportions of lowland (especially Guineo-Congolian) and Afromontane species and that is dominated by *Baikiaea insignis* (a Guineo-Congolian species) and by *Podocarpus usambarensis* var. *dawei* (an Afromontane species; White 1983 p. 181).

Fresh-water swamp forest is of restricted occurrence in the Zanzibar-Inhambane region. *Barringtonia racemosa*, a species associated with mangroves (M), often occurs in swamp forests immediately behind the mangrove zone and extends upstream for considerable distances (White 1983 p. 188).

11.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 11. Species composition of Swamp forest (edaphic forest type, fs)

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda (fsbU subtype)	Uganda (fsrU subtype)	Zambia	Coast
Acacia kirkii	Lake Victoria swamp forest		f		f	f	f	C	f	
Acrostichum aureum	Zanzibari-Inhambane swamp forest (fern species)					f				x
Albizia glaberrima	Somalia-Masai riparian forest		f	f		f	x	f	f	f
Alchornea hirtella			f	f	f	f	x	f	x	
Anthocleista grandiflora			C	x		f	f	f		x
Anthocleista schweinfurthii	Lake Victoria swamp forest	f			f	f	x	f	C	
Antidesma venosum		C	f	f		f	f	f	f	f
Apodytes dimidiata	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f	f	f	x	f	f	f
Aporrhiza nitida	Zambezian swamp forest			f					x	
Baikiaea insignis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river (dominant)				f	f	D	f		
Barringtonia racemosa	Zanzibar-Inhambane swamp forest, also mangrove associated species		f			f				x
Beilschmiedia ugandensis			f			f	x	f	C	
Blighia unijugata		f	f	f	C	f	x	C	f	f
Bridelia micrantha		f	f	f	f	f	x	f	x	f
Canarium schweinfurthii	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river	f				f	x	f	f	
Celtis africana		f		f	C	f	f	f	f	f
Celtis gomphophylla		f	f	f	f	C	f	C	f	f
Clausena anisata		f	f	f	f	f	x	f	x	f
Combretum imberbe	Zambezian deciduous riparian forest			f		f			f	f
Cordia africana		f	f	f	C	f	x	f	f	
Cordyla africana	Zambezian deciduous riparian forest		C			C			f	f
Craterispermum laurinum	Zambezian swamp forest		f						x	
Croton megalocarpus	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river		f	f	f	f	x	f	f	
Diospyros mespiliformis	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	f	C	f		f	f	f	f	f
Dombeya rotundifolia		f	f	f	C		f	f	f	
Dracaena cameroniana	Zambezian swamp forest								x	
Ekebergia capensis	riparian forest in the greater Serengeti region	f	f	f	C	f	x	f	x	f
Elaeis guineensis	Zanzibar-Inhambane swamp forest (palm species)		f	f		f	f	f		x
Erythrina abyssinica		f	f	f	x	f	x	f	f	f
Erythrina excelsa	Lake Victoria swamp forest		f			f	x	f	f	
Erythrophleum suaveolens	Zambezian evergreen or semi-evergreen riparian forest		f	f		C	f	f	f	f
Erythroxylum fischeri			C			f	x	f		
Euclea divinorum		f	f	f	C	f	f	f	f	f
Faidherbia albida		f	C	f	f	f	f	f	f	f
Ficalhoa laurifolia				f	f	f	f	f	C	
Ficus natalensis			C	f	f	f	x	f	f	f
Ficus sur	Zambezian deciduous riparian forest	f	C	f	f	f	x	f	C	x
Ficus sycomorus	Somalia-Masai, Sudanian and Zambezian deciduous riparian forest	f	x	f	x	f	x	f	f	x
Ficus trichopoda	Lake Victoria swamp forest; Zambezian swamp forest			x	C	f	f	f	C	
Ficus vallis-choudae		f	f	f	C	f	f	f	f	f
Flueggea virosa		f	f	f	f	f	x	x	f	f
Funtumia africana			C	f		f	x	f		f
Garcinia smeathmannii	Zambezian swamp forest			f		f			x	
Gardenia imperialis	Zambezian swamp forest			f		f	f	f	x	
Hallea stipulosa	Lake Victoria swamp forest; Zambezian swamp forest			x		x	f	f	C	
Hibiscus tiliaceus	Zanzibar-Inhambane swamp forest, also mangrove associated species		x			f				x
Ilex mitis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river; Zambezian swamp forest	f	f	f	f	f	C	f	C	
Khaya anthotheca	Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest		f	f		C	f	f	f	f
Kigelia africana	Somalia-Masai and Zambezian deciduous riparian forest		f	f	f	f	x	C	f	f
Klainedoxa gabonensis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river					f	x	f	f	
Lannea schweinfurthii			f	f	C	f	f	f	f	f
Lecaniodiscus fraxinifolius	Somalia-Masai (including greater Serengeti region) and Zambezian deciduous riparian forest		f	f		f	x	f	f	f
Macaranga monandra	Lake Victoria swamp forest					f	x	f		
Macaranga schweinfurthii	Lake Victoria swamp forest		C		x	f	x	f	f	
Macaranga spinosa	Lake Victoria swamp forest					C				
Maesa lanceolata		f	f	f	f	f	x	f	x	
Maesopsis eminii	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		f		f	f	x	f	f	
Musanga cecropioides	Lake Victoria swamp forest					x	f	f		
Newtonia buchananii	Zambezian evergreen or semi-evergreen riparian forest; near streams in Afromontane dry transitional forest		C	f	f	f	f	f	f	f
Parinari excelsa				f	f	f	x	f	C	f

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda (fsbU subtype)	Uganda (fsrU subtype)	Zambia	Coast
Parkia filicoidea	Lake Victoria swamp forest (also Somalia-Masai and Zambezian evergreen or semi-evergreen riparian forest)		C	f		f	x	f	f	f
Peddiea fischeri			f		f	f	x	f	x	
Phoenix reclinata	Lake Victoria swamp forest; Zanzibar-Inhambane swamp forest; palm species	C	f	x	f	f	f	C	x	x
Podocarpus falcatus	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f	f	f	f	f		
Podocarpus latifolius	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river		f	f	x	f	D	f	f	
Podocarpus usambarensis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river (dominant [*Podocarpus usambarensis* var. *dawei*])		f			f	D	f		
Pseudospondias microcarpa	Lake Victoria swamp forest; Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		C		f	f	x	f	f	
Psychotria mahonii			C	f	f	f	x	f	f	
Psychotria peduncularis	Zambezian swamp forest		f	f	x	f	f	f	x	
Pterocarpus tinctorius				f		C			f	f
Pycnanthus angolensis	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river					f	x	f	f	
Raphia farinifera	Lake Victoria swamp forest (palm species)		C	x		f	x	f	C	x
Rauvolfia caffra			f	f		f	x	D	C	f
Ritchiea albersii		f	f		C	f	x	f	f	
Rothmannia urcelliformis		f	f	f		f	x	x	f	
Schrebera arborea							x	C		
Scutia myrtina		f	f	f	C	f	x	f	x	
Shirakiopsis elliptica		f	f	f	C	f	x	f	C	
Sorindeia madagascariensis			C	f		f				x
Spondianthus preussii	Lake Victoria swamp forest					f	C	f		
Sterculia tragacantha					f	f			C	
Strombosia scheffleri	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river		f	f	f	f	x	f		f
Strychnos mitis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f		f	x	f		f
Symphonia globulifera	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river				f	f	x	f	f	
Syzygium cordatum	Lake Victoria swamp forest; Zambezian swamp forest		f	D	C	f	f	x	C	f
Syzygium guineense	Sudanian riparian forest (*Syzygium guineense* ssp. *guineense*)	C	f	f	x	f	x	f	f	f
Syzygium owariense	Zambezian swamp forest			D		f	f	f	C	
Terminalia sambesiaca	Somalia-Masai riparian forest		f	f		C			f	f
Tetrapleura tetraptera	Guineo-congolian species in forests on alluvial deposits at the mouth of the Kagera river		f				x	f		f
Trichocladus ellipticus	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f	f	f	x	f	f	
Typhonodorum lindleyanum	Zanzibar-Inhambane swamp forest					f				x
Uapaca guineensis	Lake Victoria swamp forest; Zambezian swamp forest			f		f			C	f
Vangueria madagascariensis		f	C	f		f	f	f		f
Vepris nobilis		f	f	f	C	f	x	f	f	f
Vitex doniana	Sudanian riparian forest	f	f	f	f	f	f	f	f	x
Voacanga thouarsii	Lake Victoria swamp forest; Zanzibar-Inhambane swamp forest		C	f		x	f	f	x	x
Warburgia ugandensis	Afromontane species in forests on alluvial deposits at the mouth of the Kagera river	f	f	f		f	x	f		
Xylopia aethiopica	Zambezian swamp forest		f			f	x	f	C	f
Xylopia rubescens	Zambezian swamp forest					f	f	f	C	
Ziziphus pubescens		f	C	f		f	f	f	f	f

12. Biotic *Acacia* wooded grassland (We)

12.1. Description

Where domestic animals [5] are numerous, East African evergreen bushland (Be, see Volume 4) has been severely degraded and invaded by *Acacia* species. It is therefore typical to find ***Acacia drepanolobium*** (a species that also occurs in Somalia-Masai edaphic grassland [we]), ***Acacia hockii, Acacia kirkii*** and ***Acacia seyal*** (a species that also occurs in Somalia-Masai edaphic grassland [we])) occurring together with evergreen species such as *Carissa edulis*, *Dodonaea viscosa*, *Euclea divinorum*, *Euclea racemosa* and *Tarchonanthus camphoratus* (White 1983 p. 115). In the greater Serengeti region, ***Acacia gerrardii*** dominates secondary wooded grassland that replaces evergreen bushland, but it also occupies large areas of poorly drained clay soils (White 1983 p. 128).

Evergreen bushland (Be) communities of the Lake Victoria region have been extensively destroyed and replaced by a lightly wooded *Acacia* grassland dominated by ***Acacia hockii, Acacia gerrardii, Acacia kirkii, Acacia senegal*** (the latter also a characteristic species of deciduous bushland [Bd][6]) and *Euphorbia candelabrum* (also an emergent of evergreen bushland [Be]). White (1983 p. 182) cites references from Lebrun (1947, 1955) and Liben (1961) that suggest the pathways how evergreen thicket can regenerate within biotic *Acacia* wooded grassland. In one pathway, liana species germinate in the shade of the Acacias. These lianas eventually smother the crowns of the Acacias, which then creates suitable conditions for the establishment of shrubs and bushes. The shade from these shrubs and bushes finally completely suppresses the heliophilous ('sun-loving') Acacias that are no longer able to regenerate. In the alternative pathway, the shade from *Euphorbia candelabrum* causes a diminution in the vigour of the grass layer which then allows the invasion of woody plants (White 1983 p. 182).

We suggest that biotic *Acacia* wooded grassland is an **alternative steady state** of potential natural vegetation (corresponding to disturbance by animals) to the steady state of evergreen bushland (Be, corresponding to limited disturbance by animals). The degree of grazing pressure therefore determines the proportions of biotic *Acacia* wooded grassland compared to evergreen bushland (Be).

5: The same situation arises with wild animals

6: The variety of *Acacia senegal* var. *senegal* is a typical variety of biotic *Acacia* wooded grassland, whereas the variety of *Acacia senegal* var. *kerensis* is a typical variety of deciduous bushland (Bd; F. Gachathi, pers. comm.).

Figure 12 .1. Vegetation that was originally classified as "*Acacia* wooded grassland of the Rift Valley" (ACB-RV) was reclassified by VECEA as biotic *Acacia* wooded grassland. Early dry season aspect with discontinuous ground cover. Awash National Park near the Fantale volcano (Ethiopia). Photograph by I. Friis and Sebsebe Demissew (October 2006). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 16A. 2010.

Figure 12.2. *Acacia senegal* var. *senegal* in Kajiado District (Kenya). The variety of *Acacia senegal* var. *senegal* is a typical variety of biotic *Acacia* wooded grassland, whereas the variety of *Acacia senegal* var. *kerensis* is a typical variety of deciduous bushland (Bd). Photograph by F. Gachathi (2008).

Figure 12.3. Vegetation that was originally classified as "*Acacia – Cymbopogon / Themeda* dry *Acacia* savanna" (original mapping unit P1; *Cymbopogon* and *Themeda* are grass genera) was reclassified as biotic *Acacia* wooded grassland by VECEA. The picture shows an area close to drier *Combretum* wooded grassland (Wcd) near Maddu (Uganda). Photograph by J. Kalema (November 2010).

Figure 12.4. Biotic *Acacia* wooded grassland in Akagera National Park (Rwanda). Photograph by C.K. Ruffo (October 2009).

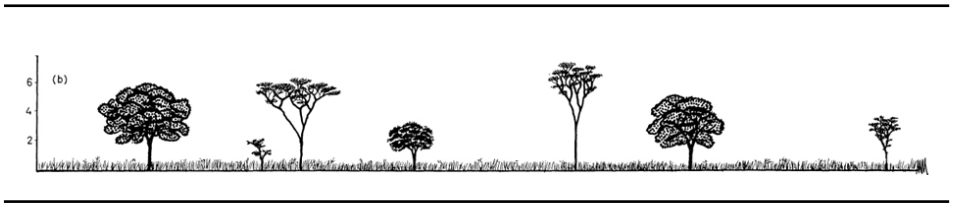


Figure 12.5. *Acacia gerrardii – Acacia seyal* wooded grassland with Themeda grass understorey. Height of vegetation in meter. Pratt *et al.* (1966, Fig 3b). Image obtained from URL: *http://www.jstor.org/stable/2401259*

12.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 12. Species composition for biotic *Acacia* wooded grassland (We)

SPECIES	Regional status	Ethiopia	Kenya	Rwanda	Tanzania	WecU (Uganda subtype)	WesU (Uganda subtype)
Acacia gerrardii	indicator species	f	C	C	f	C	C
Acacia hockii	indicator species	f	C	x	f	x	x
Acacia kirkii	indicator species		C	C	f	f	f
Acacia senegal	indicator species	C	x	C	f	x	f
Acokanthera schimperi	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Capparis tomentosa	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Carissa spinarum	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Cussonia holstii	indicator species for evergreen and semi-evergreen bushland and thicket (transition to forest)	f	f	x	f	f	f
Dodonaea viscosa	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Elaeodendron buchananii	indicator species for evergreen and semi-evergreen bushland and thicket (transition to forest)	f	f	x	f	f	f
Euclea divinorum	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Euclea racemosa	indicator species for evergreen and semi-evergreen bushland and thicket	f	f	x	f	f	f
Euphorbia candelabrum	indicator species	C	x	C	f	x	f
Grewia bicolor	indicator species for evergreen and semi-evergreen bushland and thicket	f	x		f	f	f
Grewia similis	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Pterolobium stellatum	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	x	f	f	f
Rhus natalensis	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Schrebera alata	indicator species for evergreen and semi-evergreen bushland and thicket (transition to forest)	f	f	x	f	f	f
Scutia myrtina	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	f	f	f	f
Tarenna graveolens	indicator species for evergreen and semi-evergreen bushland and thicket	f	x	x	f	f	f
Acacia drepanolobium	characteristic species	f	C		f	f	x
Acacia seyal	characteristic species	C	C	C	f	f	x
Grewia tembensis	characteristic species for evergreen bushland and deciduous bushland	f	x				
Acacia brevispica		f	C	f	f	f	f
Acacia mellifera	not characteristic	f	C		f	f	f
Acacia polyacantha		f	C	C	f	f	f
Acacia sieberiana		f	x	C	f	x	f
Acacia tortilis	not characteristic	C	C		f	f	f
Acacia xanthophloea			C		f		
Albizia adianthifolia			f	C	f	x	f
Albizia amara	not characteristic	f	C	C	f	f	f
Allophylus rubifolius		f	x	x	f	f	f
Bersama abyssinica		f	x	x	f	f	f
Boscia angustifolia		f	x	x	f	f	f
Boscia salicifolia		f	x		f	f	x
Combretum molle		f	x	x	f	f	x
Commiphora habessinica		f	x	x	f	f	f
Cordia africana		f	x	x	f	f	f
Cussonia arborea		f	x	x	f	f	f
Dichrostachys cinerea		x	x	f	f	f	f
Dombeya buettneri		f		x			
Dombeya rotundifolia		f	x	x		f	f
Entada abyssinica		f	f	C	f	x	f
Erythrina abyssinica		f	x	x	f	f	f
Erythrina burttii			x				f
Faidherbia albida		C	x		f	f	f
Ficus glumosa		f	x	x	f	f	f
Gardenia ternifolia		f	x	x	f	x	f
Lannea fulva			f	x	f	f	f
Lannea humilis	not characteristic	f	f	x	f	f	x
Lannea schimperi		f	x	x	f	f	x
Lannea schweinfurthii		f	x	x	f	f	f
Maytenus senegalensis		x	x	x	f	x	f
Ozoroa insignis		f	x	x	f	f	f
Pappea capensis		f	x	x	f	f	f
Parinari curatellifolia			x	C	f	f	f
Senna didymobotrya		f	x	x	f	f	f
Terminalia brownii		x	x		f	f	f
Vangueria infausta			x	x	f	f	f
Ximenia americana		f	x	x	f	f	f
Ziziphus abyssinica		f	x	f	f	f	x
Ziziphus mucronata		f	x	x	f	f	f

13. Palm wooded grassland physiognomically easily recognized type, P

13.1. Description

White (1983) did not describe palm wooded grasslands as a separate vegetation type in his main treatment of floristic regions. However, he describes ***Hyphaene coriacea*** palm stands that occur on sites with permanent ground water at the edge of the Chalbi desert and at the base of Mt. Kulal (White 1983 p. 123). ***Borassus aethiopum*** and ***Hyphaene petersiana*** (synonym: *Hyphaene ventricosa*) are among the characteristic species of the riparian woodland subtype of Undifferentiated woodland and wooded grassland (Wn, White 1983 p. 95). ***Borassus aethiopum*** is listed to occur in seasonally inundated flood plains in the Sudanian floristic region (White 1983 p. 107). ***Borassus aethiopum*** and ***Hyphaene thebaica*** occur on transition zones between swamp grassland and better drained areas with *Acacia seyal* in the flood region of the Nile (White 1983 p. 108). ***Hyphaene compressa*** occurs in Zanzibar-Inhambane edaphic wooded grassland (White 1983 p. 189). ***Phoenix reclinata*** and ***Raphia farifera*** are palm species that are listed among the more important species of swamp forests that are widespread in the Lake Victoria region and elsewhere (White 1983 p. 181). *Phoenix reclinata* occurs in swamp forests in the Zanzibar-Inhambane region (White 1983 p. 188).

Lind and Morrison (1974 p. 94) mention that palm wooded grassland is limited in area, but so noticeable that it needed to be included in descriptions of East African vegetation types. The main species is ***Borassus aethiopum***. In Uganda, it is found on sands and sandy loams with mobile ground water. In Kenya, it is scattered through the coastal belt and is noticeable on the Shimba Hills. In Tanzania, extensive stands occur in the flood plains of the Igombe and Ugala rivers and other riverine communities where it is sometimes accompanied by *Hyphaene* doum palm species. ***Hyphaene coriacea*** is the dominant palm species on the Ruaha - Usangu plain complex and in the Warmi and Mkata flood plains. *Borassus* stands are more common than *Hyphaene* in parts of the coastal plain, but small trees (up to 3 m) of *Hyphaene* form extensive stands in grassland on poorly drained sands.

From the descriptions above it is clear that the palm stands that were described often occur in areas with drainage impediments or riverine locations. It would therefore be perfectly acceptable to classify and map these vegetation types as "edaphic wooded grassland" (wd) or "riverine wooded grassland" (wr), which we have done in several situations. We think that discrimination between these types is more a question of the scale of mapping since palm trees can easily be identified in the field.

Figure 13.1. *Borassus - Hyperthelia dissoluta* [a grass species, synonym: *Hyparrhenia dissoluta*,] palm wooded grassland (original mapping unit M2) from Uganda. Photograph by J. Kalema.

Figure 13.2. Stand of *Phoenix reclinata* in waterlogged area within Afromontane rain forest (Fa). Photograph by I. Friis and Sebsebe Demissew. Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 25G. 2010.

Figure 13.3. *Hyphaene petersiana* wooded grassland next to the Shire River marsh and lagoons (Liwonde National Park, Malawi). An alternative classification method for this vegetation type would have been as "edaphic wooded grassland on drainage-impeded or seasonally flooded soils". Photograph by C. Dudley.

13.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 13. Species composition for Palm wooded grassland physiognomically easily recognized type, P

SPECIES	Regional Status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	P1U (Uganda subtype	P2U (Uganda subtype	Zambia	Coast
Borassus aethiopum	Palm species (occurs in the riparian woodland subtype of north Zambezian undifferentiated woodland, in Sudanian edaphic grassland on Pleistocene clays, and in Zanzibar-Inhambane secondary grassland and wooded grassland)	C	C	f		f	D	D	f	C
Cocos nucifera	Palm species (occurs in Zanzibar-Inhambane edaphic grassland and secondary grassland)		C			f				C
Elaeis guineensis	Palm species		C	f		f	f	f		C
Hyphaene compressa	Palm species (occurs in Zanzibar-Inhambane edaphic grassland and secondary grassland)	C	C			f				C
Hyphaene coriacea	Palm species (small stands with permanent ground water at the edge of the Chalbi desert and at the base of Mt. Kulal)		C			f				C
Hyphaene petersiana	Palm species (occurs in the riparian woodland subtype of north Zambezian undiffertiated woodland)			D		f			C	
Hyphaene thebaica	Palm species (occurs in Sudanian undifferentiated woodland and in Sudanian edaphic grassland on Pleistocene clays)	C								
Phoenix reclinata	Palm species (small communities in areas with frequent landslides on Mt. Kulal, Lake Victoria swamp forest, Zanzibar-Inhambane swamp forest	C	C	f	C	f	f	f	f	C
Raphia farinifera	Palm species (occurs in Lake Victoria swamp forest)		C	f		f	f	f	f	C
Acacia erioloba									C	
Acacia nigrescens				C					f	
Acacia polyacantha				f			x	x	f	
Acacia sieberiana				C			x	x	f	
Acacia xanthophloea				C						
Adansonia digitata				C					f	
Albizia versicolor				C			f	f	f	
Burkea africana				f			f	f	C	
Combretum collinum				f			x	x	f	
Diospyros mespiliformis				C			f	f	f	
Faidherbia albida				C			f	f	f	
Kigelia africana				C				x	f	
Lannea schweinfurthii				C			f	f	f	
Lonchocarpus capassa				C					f	
Piliostigma thonningii				C			x	x	f	
Sterculia africana				C					f	
Terminalia sericea				f					C	
Trichilia emetica				C			f	f	f	

14. Evergreen and semi-evergreen bushland and thicket (synonym: evergreen bushland, Be)

14.1. Description

Within volumes 2 to 5, we use the synonym of "evergreen bushland (Be)" as a synonym of "evergreen and semi-evergreen bushland and thicket (Be)".

White (1983) describes evergreen and semi-evergreen bushland and thickets within the descriptions of two floristic regions: (i) the Somalia-Masai regional centre of endemism ('East African evergreen and semi-evergreen bushland and thicket'); and (ii) the Lake Victoria regional mosaic ('evergreen and semi-evergreen bushland and thicket and derived communities').

Evergreen and semi-evergreen bushland and thicket occurs on the drier slopes of mountains and upland areas in East Africa which rise from the lowlands from the Somalia-Masai region all the way from central Tanzania to Eritrea (and beyond). It often forms an ecotone between Afromontane forest (especially Afromontane single-dominant *Juniperus procera* forest [Fbj]) and deciduous bushland (Bd) - this pattern of occurrence can be clearly observed in northern Kenya such as at on the lower slopes of Mt. Marsabit (2º 16' N, 37º 57' E). The mean annual rainfall is mostly between 500 and 850 mm and is irregularly distributed throughout the year but with two main peaks (White 1983 pp. 48 and 115).

Evergreen bushland varies greatly in composition and richness, but certain species that are nearly always present include ***Acokanthera schimperi, Carissa spinarum, Dodonaea viscosa, Euclea divinorum, Euphorbia candelabrum, Olea europaea*** subsp. ***cuspidata*** (synonym: *Olea africana*), ***Tarchonanthus camphoratus*** (especially in disturbed areas), ***Vepris simplicifolia*** (synonym: *Teclea simplicifolia*) together with other species of *Acokanthera, Aloe, Euclea, Euphorbia, Sanseviera* and *Vepris*. Succulents such as ***Dracaena ellenbeckiana*** and ***Euphorbia candelabrum*** that are present in evergreen bushland are absent from Afromontane single-dominant *Juniperus procera* forest (Fbj, White 1983 p. 115).

Evergreen bushland (in mosaic with Lake Victoria *Euphorbia dawei* scrub forest [fe, see Volume 2] that is edaphically restricted to rocky slopes) probably represents the climax vegetation of large parts of the Lake Victoria region. This evergreen bushland variant is floristically similar but also floristically poorer than the vegetation type with the same name that occurs in the Somalia-Masai region. The principal bushy species include ***Allophylus africanus, Azima tetracantha, Carissa spinarum*** (also listed as characteristic in East Africa), ***Capparis fascicularis*** (listed as a characteristic climber in East Africa), ***Capparis tomentosa, Erythrococca bongensis, Grewia bicolor, Maerua triphylla, Olea europaea*** subsp. ***cuspidata*** (synonym: *Olea africana*, also listed as characteristic in East Africa), ***Psydrax schim-***

periana, Rhus natalensis (also listed as characteristic in East Africa), *T**arenna graveolens*** **and** ***Turraea nilotica***.

Annual rainfall is higher in places where evergreen bushland occurs in the Lake Victoria region (850 mm to 1000 mm) than those places where it occurs in the Somalia-Masai region (500 to 850 mm; White 1983 pp. 48 and 182).

Where evergreen bushland is degraded (as a result from grazing), various *Acacia* species invade and **biotic Acacia wooded grassland (We)** becomes established. This vegetation type forms an alternative steady state of potential natural vegetation to evergreen bushland (*i.e.* it is possible for both types of potential natural vegetation to become established in the areas where they are mapped separately).

The grasslands of the Loita and other plains that occur in Narok district (including parts of the Masai-Mara reserve) are similar in grass species composition as the edaphic grasslands on volcanic soils of the Serengeti plains (gv, see Volume 5). However, these grasslands in Narok district are secondary to evergreen bushland as a result from fire and browsing (White 1983 p. 127). Areas capable of supporting evergreen bushland in Nairobi National Park have been converted to grassland as a result from browsing, grazing and fire (White 1983 p. 116).

White (1983) describes relatively undisturbed evergreen bushland (locally impenetrable) that occurred near Nairobi between 1875 and 2080 m. Most of the species that White (1983) listed as characteristic were indicator species (see also section 4.3). Only two species were also listed as characteristic species for deciduous bushland (Bd): *Grewia tembensis* (listed as a smaller bush and shrub for deciduous bushland and thicket, and as a large bush in East African evergreen bushland) and *Sarcostemma viminale* (a succulent climber).

The indicator species can be further categorized in: (i) characteristic species of the main canopy; (ii) other large bushes; (iii) scattered emergents; (iv) shrubs; (v) climbers; and (vi) scattered stunted individuals that indicate the transition to Afromontane single-dominant *Juniperus procera* forest (Fbj).

- Characteristic species of the main canopy (3 to 7 m) include ***Acokanthera schimperi, Euclea divinorum, Gnidia subcordata, Olea europaea*** subsp. ***cuspidata*** (synonym: *Olea africana*], also listed as characteristic species for the Lake Victoria region), ***Tarchonanthus camphoratus*** (especially in disturbed areas) and *V**epris simplicifolia***. (White (1983) did not list ***Carissa spinarum***, but this could be an omission).
- Other large bushes include ***Canthium keniense, Croton dichogamus, Dodonaea viscosa, Dombeya burgessiae, Grewia similis, Maytenus heterophylla*** and ***Rhus natalensis*** (also listed as characteristic species for the Lake Victoria region).
- ***Euphorbia candelabrum*** (a cactoid stem-succulent) occurs throughout as a scattered emergent up to 9 m tall. This species was also listed as a characteristic species for the Lake Victoria region.

- Shrubs include ***Aspilia mossambicensis, Psiadia punctulata, Tinnea aethiopica*** and ***Turraea mombassana***.
- Climbers include ***Capparis fascicularis*** (also listed as characteristic species for the Lake Victoria region), ***Pterolobium stellatum*** and ***Scutia myrtina***.
- Scattered stunted individuals that indicate the transition to Afromontane single-dominant *Juniperus procera* forest (Fbj) appear at higher altitudes and include ***Calodendrum capense, Cussonia holstii, Drypetes gerrardii, Elaeodendron buchananii, Juniperus procera*** (evergreen bushland could be the original habitat of this species [White 1983 p. 165]) and ***Schrebera alata***.

Figure 14.1. Evergreen thicket in Queen Elizabeth National Park (Uganda). Emergent *Euphorbia candelabrum* covered by climbers can be seen in various places. Photograph by M. Namaganda (June 2008).

Figure 14.2. Evergreen and semi-evergreen bushland next to a remnant of Afromontane single-dominant *Juniperus procera* forest (Fbj). Near Arero (Ethiopia). Approximate altitude 1800m. Photograph by I. Friis and Sebsebe Demissew (September 2002). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 23A. 2010.

Figure 14.3. Stands of *Dracaena ombet* subsp. *ombet* in *Acacia*-dominated bushland below remnants of Afromontane single-dominant *Juniperus procera* forest (Fbj). Between Wukro and Berahile (Ethiopia). Approximate altitude 1700 m. Photograph by I. Friis and Sebsebe Demissew (October 2009). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 23B. 2010.

Figure 14.4. Regrowth of *Tarchonanthus camphoratus* in evergreen bushland in a transition zone between *Acacia-Commiphora* deciduous bushland and Afromontane single-dominant *Juniperus procera* forest (Fbj). Between Wukro and Berahile (Ethiopia). Approximate altitude 2000 m. (October 2009). Photograph by I. Friis and Sebsebe Demissew. Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 23D. 2010.

Figure 14.5. Evergreen bushland and thicket in Biharagu (Rwanda). Photograph taken by E. Munyaneza (October 2009).

Figure 14.6. Evergreen bushland was the original vegetation type of most of the Akagera National Park (Rwanda). Photograph by V. Minani (March 2007).

Figure 14.7. As a result from grazing, the original evergreen bushland of Akagera national park (Rwanda) has changed to the alternative steady state of biotic Acacia wooded grass-land (We). Climbers growing on Euphorbia candelabrum (right) can initiate the vegetation succession to evergreen bushland (see also Lebrun [1947] and White [1983 p. 183]; Photograph by D. König (September 1987).

Figure 14.8. Evergreen bushland in the Maasai Mara (original mapping unit 24). The photograph shows Diospyros abyssinica together with typical evergreen bushland species of *Euclea divinorum, Olea europaea* ssp. *cuspidata* (synonym: *Olea africana*). Person: C.G. Trapnell. Photography by E.C. Trump.

14.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 14. Species composition for Evergreen and semi-evergreen bushland and thicket (synonym: evergreen bushland, Be)

SPECIES	Regional status	Ethiopia	Kenya (BeeK subtype)	Kenya (BewK subtype)	Rwanda	Tanzania	Uganda (BemU subtype)	Uganda (BedU subtype)
Acokanthera schimperi	indicator species	C	x	x	x	f	f	f
Allophylus africanus	indicator species	f	f	x	f	f	x	C
Aloe kedongensis	indicator species		x					
Aspilia mossambicensis	indicator species	f	f	f		f	f	f
Azima tetracantha	indicator species			x	x		f	f
Canthium keniense	indicator species		x					
Capparis fascicularis	indicator species	f	x	x	x	f	f	x
Capparis tomentosa	indicator species	f	x	x	C	f	f	x
Carissa spinarum	indicator species	f	x	x	C	x	x	x
Croton dichogamus	indicator species	f	x	x	x	x	f	
Dodonaea viscosa	indicator species	C	x	x	f	f	f	f
Dombeya burgessiae	indicator species		x	f	f	f	f	
Dracaena ellenbeckiana	indicator species	C	x	f		f	f	
Erythrococca bongensis	indicator species	f	f	x	x	f	f	
Euclea divinorum	indicator species	C	x	x	x	x	x	f
Euphorbia candelabrum	indicator species	f	x	x	f	x	x	C
Gnidia subcordata	indicator species		x	x		f	f	
Grewia bicolor	indicator species	f	x	x		f	f	f
Grewia similis	indicator species	x	x	x	C	x	C	x
Maerua triphylla	indicator species	f	x	x	x	f	f	
Maytenus heterophylla	indicator species	f	x	f	x	f	f	
Olea europaea	indicator species	C	x	x	C	x	f	f
Psiadia punctulata	indicator species	x	x			f		
Psydrax schimperiana	indicator species	f	x	x	x	f	f	f
Pterolobium stellatum	indicator species	f	x	x	f	f	f	f
Rhus natalensis	indicator species	f	x	x	x	x	x	f
Scutia myrtina	indicator species	f	x	x	x	f	x	f
Tarchonanthus camphoratus	indicator species	C	x	x		f	f	
Tarenna graveolens	indicator species	x	x	x	x	C	f	x
Tinnea aethiopica	indicator species	f	x	x		f	f	x
Turraea mombassana	indicator species	x	x			f		
Turraea nilotica	indicator species	f	f	x		f		
Vepris simplicifolia	indicator species	f	x	x		x		
Vernonia brachycalyx	indicator species	f	f	x	x	f	C	f
Acacia drepanolobium	characteristic species	f	C	f		f	f	f
Acacia gerrardii	characteristic species	f	C	x	f	x	f	x
Acacia hockii	characteristic species	f	C	x	f	f	f	x
Acacia kirkii	characteristic species		x	x	f	f	f	f
Acacia senegal	characteristic species	f	x	x	f	f	f	C
Acacia seyal	characteristic species	f	x	C		f	f	f
Calodendrum capense	characteristic species		x	f		f	f	f
Cissus quadrangularis	characteristic species		x	x	x	f	f	
Cissus rotundifolia	characteristic species	f	f	x		f	x	x
Cussonia holstii	characteristic species	C	x	x	x	f	f	f
Drypetes gerrardii	characteristic species		x	f	C	f	f	
Elaeodendron buchananii	characteristic species	f	x	f	x	x	f	f
Grewia tembensis	characteristic species	x	x	f				

SPECIES	Regional status	Ethiopia	Kenya (BeeK subtype)	Kenya (BewK subtype)	Rwanda	Tanzania	Uganda (BemU subtype)	Uganda (BedU subtype)
Juniperus procera	characteristic species	C	x	f		f	f	f
Sarcostemma viminale	characteristic species	f	f	f	x			
Schrebera alata	characteristic species	C	x	f	x	f	f	f
Acacia brevispica		f	C	C	x	x	C	C
Acacia lahai		f	x	x		f	f	f
Acacia mellifera	not characteristic	f	C	f		f	f	f
Acacia nilotica	not characteristic	f	x	f		f	f	x
Acacia polyacantha		f	x	x	f	f	f	f
Acokanthera oppositifolia	characteristic genus		f	x				
Albizia amara	not characteristic	f	x	f	f	f	f	x
Albizia coriaria		f	f	C		f	x	f
Albizia zygia			f	f		f	x	x
Allophylus rubifolius		f	x	x	x	f	f	f
Annona senegalensis		f	x	x	f	f	f	f
Antidesma venosum		f	f	x		f	x	f
Apodytes dimidiata		f	x	x	x	f	f	f
Balanites aegyptiaca		f	x	f	f	f	f	x
Berberis holstii		C	f	f		f	f	f
Berchemia discolor		C	f	f		f	f	f
Boscia angustifolia		f	f	f	x	f	f	x
Bridelia micrantha		f	x	x	f	f	f	f
Bridelia scleroneura		f	f	f		f	x	C
Cadaba farinosa	not characteristic	f	f	x	x	f	f	f
Canthium lactescens		x	x	f	x	f	C	f
Catha edulis		C	x	f	f	f	f	f
Clausena anisata		f	x	x	x	f	f	f
Clerodendrum myricoides		x	x	x	x	f	f	f
Combretum molle		f	x	f	x	f	f	f
Commiphora africana	not characteristic	x	f	f	f	f	f	x
Cordia monoica	not characteristic	f	x	x		x	f	f
Crotalaria agatiflora		f	x	x	f	f	f	f
Croton macrostachyus		f	x	x	x	f	f	f
Cussonia arborea		f	x	x	x	f	f	f
Dichrostachys cinerea		f	f	x	f	f	f	x
Dombeya rotundifolia		x	x	x	f		f	f
Dovyalis abyssinica		f	x	x		f	f	f
Erythrina abyssinica		f	x	x	f	f	f	f
Euclea racemosa	characteristic genus	C	x	x	x	C	x	f
Euphorbia tirucalli		x	x	x	x	f	x	x
Faurea rochetiana		f	x	f	x	f	f	f
Faurea saligna			x	x	f	f	f	f
Ficus glumosa		f	x	x	f	f	f	f
Flacourtia indica		f	x	x	x	f	f	f
Gardenia ternifolia		f	x	x	f	f	f	f
Grewia mollis		f	x	x	f	f	C	C
Harrisonia abyssinica		f	x	x	x	f	x	C
Indigofera swaziensis			x	x		f	f	f

SPECIES	Regional status	Ethiopia	Kenya (BeeK subtype)	Kenya (BewK subtype)	Rwanda	Tanzania	Uganda (BemU subtype)	Uganda (BedU subtype)
Lannea fulva			f	f	x	f	f	f
Lannea humilis	not characteristic	f	x	f	f	f	f	x
Lannea schweinfurthii		f	x	f	f	x	f	x
Lecaniodiscus fraxinifolius		f	x	x		f	f	f
Lippia kituiensis			x	x		f		
Maytenus senegalensis		f	x	f	x	f	f	f
Maytenus undata		f	x	f	x	f	f	f
Oncoba spinosa		f	x	x		f	f	f
Ormocarpum kirkii			x	f		f		
Osyris lanceolata		f	x	f	x	f	f	f
Ozoroa insignis		f	x	x	f	f	f	f
Pappea capensis		C	x	x	x	x	f	f
Pavetta crassipes		f	x	x		f	f	f
Pistacia aethiopica		C	x	f		f	f	f
Pittosporum viridiflorum		C	x	f	x	f	f	f
Rhamnus staddo		f	x	f	x	f	f	f
Rhoicissus revoilii		f	f	x	x	f	f	f
Rhoicissus tridentata		f	x	x	x	f	x	x
Rhus vulgaris		f	x	x	x	f	f	f
Senna didymobotrya		x	x	f	f	f	f	f
Solanecio cydoniifolius			x	f	x	f	f	f
Solanecio mannii		f	x	f	x	f	f	f
Steganotaenia araliacea		f	f	x	f	f	f	x
Stereospermum kunthianum		f	x	x		f	f	x
Strychnos henningsii		f	x	f		x	f	f
Terminalia brownii		f	x	x		f	f	f
Tetradenia riparia		f	x	x	f			
Vangueria apiculata		f	x	x	x	f	x	f
Vangueria infausta			x	x	x	f	f	f
Vangueria madagascariensis		x	x	x		f	x	f
Vepris nobilis	characteristic genus (synonym: Teclea)	f	x	x	x	C	C	f
Vepris trichocarpa	characteristic genus (synonym: Teclea)		x		x	C		x
Zanthoxylum chalybeum		f	x	f	x	f	f	x
Zanthoxylum usambarense		C	f	f	f	f		
Ziziphus abyssinica		f	x	x	f	f	f	C
Ziziphus mucronata		f	x	x	f	x	f	f
Ziziphus pubescens		f	x	x		f	x	f

15. Montane Ericaceous belt (easily identifiable type, E)

15.1. Description

White (1983) refers to Afromontane evergreen bushland and thickets that occur on most of the higher African mountains and that characteristically occupy a large part of the Ericaceous mountain belt. They are also found on the crests and summits of smaller mountains (especially those that are situated close to the ocean or a large lake) or locally on shallow soils within the Afromontane forest belt. Where the ground is not very rocky and has been protected for several years, such as on wetter mountains as the Ruwenzori Mts., almost impenetrable thickets of 3 to 13 m are formed. On drier and rocky slopes, the vegetation is an open community of bushes that is often discontinuous and merges into Afromontane shrubland (see below). Afromontane evergreen bushland and thicket varies greatly in floristic composition, but species of the *Blaeria*, *Erica* and *Vaccinium* Ericaceae genera are nearly always present and sometimes exclusively dominant (White 1983 p. 167 - 168). Hedberg (1951 cited in Friis *et al.* 2010 p. 113) has documented that an Ericaceous belt occurs on all the high mountains of eastern Africa.

Afromontane shrubland occurs on shallow soils and especially exposed rocky ridges. It is much shorter than Afromontane evergreen bushland and thicket and contains stunted invididuals that are dominant in the latter vegetation type. However, Afromontane shrubland also contains species that are usually absent from Afromontane evergreen bushland and thicket (White 1983 p. 168).

Ericaceous vegetation occurs at a few places on the East African coast. Evergreen bushland dominated by *Erica* (synonym: Philippia) occurs on waterlogged sites of former lagoons or lake basins (White 1983 p. 188). Interestingly, *Syzygium cordatum* is an associate that is listed both for Ericaceous vegetation on Mafia and Pemba islands (White 1983 p. 189) and for tall "elfin" thickets (3 - 7 m) that occur on peaks in the Uluguru mountains (White 1983 p. 168). We did not include coastal Ericaceous vegetation types into the "montane Ericaceous belt" as coastal vegetation is clearly not associated with mountains.

Figure 15.1. Ericaceous belt with *Erica arborea* forming woodland. The floor is completely covered by ferns, mosses and grasses. Bale Mountains (Ethiopia). Approximate altitude 3600 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 29A. 2010.

Figure 15.2. Ericaceous belt with *Erica arborea* forming woodland. This location has more grass than the location shown in Fig EA. Bale Mountains (Ethiopia). Approximate altitude 3300 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 29C. 2010.

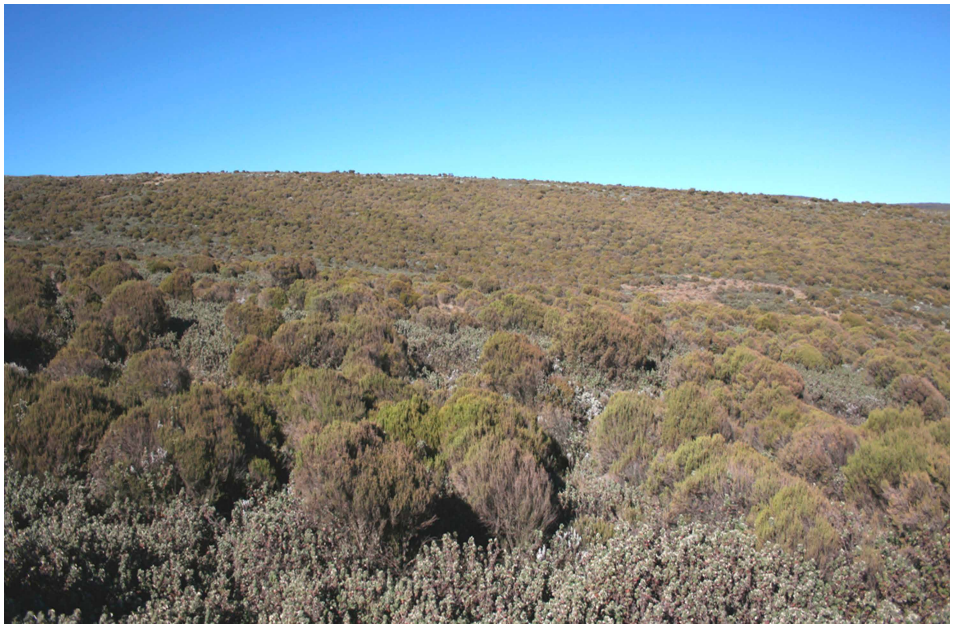


Figure 15.3. Ericaceous belt with burnt vegetation. Numerous shoots (green) appear from the burnt stumps of *Erica arborea*. In between the *Erica arborea* stumps and in the foreground, the subshrub *Alchemilla haumannii* (greyish-green) can be seen. Bale Mountains (Ethiopia). Approximate altitude 3800 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 29B. 2010.

Left: Figure 15.4. The montane Ericaceous belt on Mt. Kahuzi (Kahuzi-Biega-National Park, D.R.Congo. Photograph by E. Fischer (October 1991).

Right: Figure 15.5. *Vaccinium stanleyi*, one of the Ericaceae species of the Ericaceous belt in Rwanda. (Mt. Kahuzi, Kahuzi-Biega-National Park, D.R.Congo). Photograph by E. Fischer (October 1991).

Figure 15.6. *Erica kingaensis* subsp. *rugegensis*, one of the Erica species of the Ericaceous belt in Rwanda. Rwasenkoko Swamp, Nyungwe National Park. Photograph by E. Fischer (October 1985).

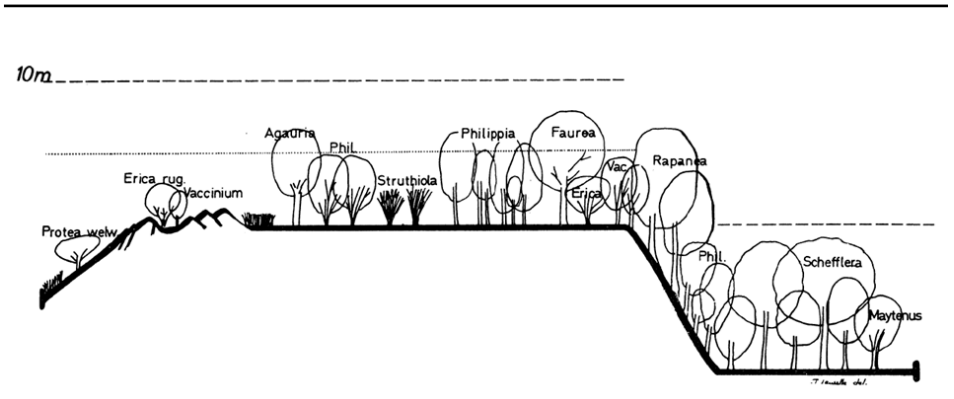


Figure 15.7. Profile diagram of Afromontane Ericaceous bushland ("fruticée sclérophylle à Ericaceae", i.e. sclerophyl scrubland with Ericaceae). This image was the only profile diagramme mentioned by White (1983 p. 167) for Afromontane evergreen bushland and thicket. Vegetation similar to the Ericaceous belt occurs on the crests and summits of some smaller mountains as shown below. Lewalle (1972, Fig. 28). Figure obtained from URL URL: http://www.jstor.org/stable/3667406

15.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 15. Species composition for Montane Ericaceous belt (easily identifiable type, E)

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda
Adenocarpus mannii		x	x	f	f	C	f
Agauria salicifolia	Ericaceae	f	C	f	C	f	f
Berberis holstii		x	x	f		f	f
Clematis simensis		x	x		f	f	f
Discopodium eremanthum		x	x			f	f
Dombeya torrida		x	x	f	f	f	f
Erica arborea	Ericaceae	C	C		f	C	x
Erica benguelensis	Ericaceae		f	C	f	f	C
Erica johnstoniana	Ericaceae			f			C
Erica johnstonii	Ericaceae				f		x
Erica kingaensis	Ericaceae				f	f	x
Erica milanjiana	Ericaceae			x			
Erica rossii	Ericaceae		C			C	
Erica trimera	Ericaceae	C	C			f	C
Erica whyteana	Ericaceae		f	x		f	
Faurea saligna			x	f	f	f	x
Gnidia glauca		x	x	f		f	f
Hagenia abyssinica		x	x	f	f	f	f
Hypericum revolutum		C	x	f	f	f	x
Morella salicifolia		x					
Rapanea melanophloeos		C	x	f	f	f	f
Rhus glutinosa		x					

16. Afroalpine vegetation (A)

16.1. Description

The vegetation of the highest mountains of tropical Africa (≥ 3800, including the Aberdares [Kenya], Mt. Elgon [Kenya and Uganda], Mt. Kenya, Mt. Kilimanjaro [Tanzania], Mt. Meru [Tanzania], the Ruwenzori Mts. [Uganda and DRC], the Virunga Mts. [Rwanda and DRC] and the higher peaks of Ethiopia [but see section 3.2]) are characterized by the occurrence of Giant *Senecio* species (up to 6 m; *Senecio* subgenus *Dendrosenecio*), Giant *Lobelia* species (up to 6 m), shrubby *Alchemilla* species and other plants of remarkable lifeforms. Since most of the species also occur in the montane Ericaceous (E, see Volume 3) and Afromontane forest belts (Fa, Fb and Fd, see Volume 2), Afroalpine vegetation can be regarded as an archipelago-like floristic region of extreme floristic impoverishment (White 1983 p. 169).

Afroalpine vegetation occurs on high mountains where night frosts are liable to occur throughout the year (White 1983 p. 46).

Knox and Palmer (1993, Fig 3) provide the following distribution pattern of the 11 species of giant *Senecio* species[7]:

- *Senecio* subgenus *Dendrosenecio adnivalis*: Ruwenzori Mts.
- *Senecio* subgenus *Dendrosenecio battiscombe*i: Aberdares and Mt. Kenya
- *Senecio* subgenus *Dendrosenecio brassiciformis*: Aberdares
- *Senecio* subgenus *Dendrosenecio cheranganiensis*: Cherangani Hills
- *Senecio* subgenus *Dendrosenecio elgonensis*: Mt. Elgon
- *Senecio* subgenus *Dendrosenecio erici-rosenii*: Ruwenzori,Virunga and Mitumba Mts.
- *Senecio* subgenus *Dendrosenecio johnstonii*: Mt. Kilimanjaro
- *Senecio* subgenus *Dendrosenecio keniensis:* Mt. Kenya
- *Senecio* subgenus *Dendrosenecio keniodendron*: Aberdares and Mt. Kenya
- *Senecio* subgenus *Dendrosenecio kilimanjar*i: Mt. Kilimanjaro
- *Senecio* subgenus *Dendrosenecio meruensis*: Mt. Meru

7: Based on analysis of chloroplast DNA, these authors suggest that the Dendrosenecio subgenus originated on Mt. Kilimanjaro

Figure 16.1. Afroalpine vegetation in the foreground with rosettes of Lobelia rhynchopetalum (before flowering). In the background the montane Ericaceous belt (see Volume 2) on the slope of the valley with Erica arborea. Semien mountains (Ethiopia). Photograph by I. Friis and Sebsebe Demissew (October 2009). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 30A. 2010.

Figure 16.2. Mosaic of grass sward and Helichrysum crispinum heath together with flowering and sterile individuals of Lobelia rhynchopetalum. Bale mountains (Ethiopia). Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 30C. 2010.

Figure 16.3. Afroalpine vegetation in the Ruwenzori Mts (Uganda). Photograph by M. Namaganda (June 2008).

Figure 16.4. Afroalpine vegetation in the Ruwenzori Mts (Uganda). Photograph by M. Namaganda (June 2008).

Figure 16.5. Afroalpine vegetation on the Karisimbi Volcano (Rwandan side of the Virunga Mts.). Photograph by E. Fischer (October 1991).

Figure 16.6. Typical East African bird species that occur in Afroalpine vegetation within their natural habitat. Shell guide to East African birds (1960; reproduced with permission from URL *http://ufdc.ufl.edu/UF00077050*).

16.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 16. Species composition for Afroalpine vegetation (A)

SPECIES	Regional status	Ethiopia	Kenya	Rwanda	Tanzania	Uganda
Alchemilla argyrophylla	characteristic (genus)		x		f	x
Alchemilla elgonensis	characteristic (genus)		x			f
Alchemilla johnstonii	characteristic (genus)		x	x	f	x
Lobelia deckenii	characteristic (genus)					C
Lobelia rhynchopetalum	characteristic (genus)	C				
Lobelia stuhlmannii	characteristic (genus)			C		
Lobelia telekii	characteristic (genus)		C			C
Lobelia wollastonii	characteristic (genus)			C		C
Senecio myriocephalus	characteristic (genus)	x				
Senecio subgenus Dendrosenecio adnivalis	characteristic (genus)					C
Senecio subgenus Dendrosenecio elgonensis	characteristic (genus)		f			C
Senecio subgenus Dendrosenecio johnstonii	characteristic (genus)		C	C		f
Senecio subgenus Dendrosenecio keniodendron	characteristic (genus)		C			
Senecio subgenus Dendrosenecio kilimanjari	characteristic (genus)				C	
Senecio subsessilis	characteristic (genus)		f	C	f	f
Adenocarpus mannii		x	f	x	f	f
Erica arborea		C	x	f	f	f
Helichrysum formosissimum				x		C
Hypericum revolutum		C	f	f	f	f

17. Afromontane bamboo (B)

17.1. Description

Sinarundinaria alpina (synonym: *Arundinaria alpina*) is one of the four bamboo species (giant grasses with erect woody stems of 2 - 20 m [or even taller] that sometimes form pure and virtually impenetrable communities, and that persist for several years, then flower gregariously and then die back,) that are indigenous to Africa (the other species are *Oxytenanthera abyssinica* [mapped in the VECEA map as "L", see below], *Oreobambos buchwaldii* [it was recorded within species assemblages for various forest vegetation types] and *Arundinaria tessellata* [current name: *Thamnocalamus tessellatus*; it replaces ***Sinarundinaria alpina*** in South Africa]). ***Sinarundinaria alpina*** occurs on most of high mountains of East Africa (Ethiopia to southern Tanzania), but south of Tanzania it is only known to occur on the North Viphya Plateau (Malawi), Dedza Mt. (Malawi) and Mt. Mulanje (Malawi); White 1983 pp. 55 and 166). The Flora Zambesiaca confirms that ***Sinarundinaria alpina*** does not occur in Zambia. The species presently does not occur on the North Viphya Plateau (C. Dudley, personal observations).

In East Africa, *Sinarundinaria alpina* is mostly found between 2400 and 3000 m, although it ascends on Mt. Kenya to 3500 m and descends in the Uluguru Mts. (Tanzania) to 1630 m. It grows most vigorously on deep volcanic soils and gently slopes where the annual rainfall exceeds 1250 mm. The largest areas are found on the Aberdare Range (Kenya, 65000 ha), the Mau Range (Kenya, 51000 ha) and Mt Kenya (39000 ha; White 1983 p. 166). ***Sinarundinaria alpina*** does not form a belt on Mt. Kilimanjaro, whereas a bamboo belt occurs on the adjacent Mt. Meru (White 1983 p. 167).[8]

Hemp (2006) provides the following speculations about the absence of the bamboo zone on Mt. Kilimanjaro:

> "Another feature of the forests of Kilimanjaro is the absence of a bamboo zone, which occurs on all other tall mountains in East Africa with a similarly high rainfall. Observations on other East African mountains showed that the occurrence of bamboo is linked to a special type of disturbance: the activity of large herbivores. ***Sinarundinaria alpina*** stands are favoured by elephants and buffaloes. On Kilimanjaro these megaherbivores occur on the northern slopes, where it is too dry for a large bamboo zone to develop. They are excluded from the wet southern slope forests by topography and humans who have cultivated the foothills for at least 2000 years. From studies on Mt Kenya (Vanleeuwe and Lambrechts [1999]) it is known that elephants climb slopes only up to a steepness of about 30 degrees. On the south-western and north-eastern slopes of Kilimanjaro, very deep (up to several 100 m) and very steep (>30 degree) valleys exist, which reach high up into the alpine zone. These deep gorges prevent large herbivores migrating from the northern side of the mountain to the southern. Combined with human occupation of the wetter slopes, this

8: Friis *et al.* 2010 (p. 95) mention that Hedberg only recorded distinct mountain bamboo zones from the Aberdares, Mt. Elgon, Mt. Kenya, Mt. Meru, Ruwenzori Mts., and Virungu Mts.

means that the southern and south-eastern montane forests of Mt Kilimanjaro are no longer accessible for buffaloes and elephants. This interplay of biotic and abiotic factors could explain not only the lack of a bamboo zone on Kilimanjaro but also offers possible explanations for the patterns of diversity and endemism."

Various tree species occur scattered within the bamboo. These tree species probably became established when bamboo plants died following their gregarious flowering (White 1983 p. 167).

Figure 17.1. Afromontane bamboo (*Sinarundinaria alpina;* synonym: *Arundinaria alpina*) in Kabatwa (Volcanoes National Park, Rwanda). Photograph by V. Minani (October 2009).

Figure 17.2. Afromontane bamboo (*Sinarundinaria alpina*; synonym: *Arundinaria alpina*) on Mt. Elgon, Ugandan side. Photograph by E.Fischer (October 1997).

Figure 17.3. Edge of thicket of Afromontane bamboo (*Sinarundinaria alpina*; synonym: *Arundinaria alpina*) near Masha (Ethiopia). In the national reference for Ethiopia, Afromontane bamboo was not described separately from Afromontane forest types in which Afromontane bamboo occurs; this image was included with images for Afromontane rain forest (Fa). Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 25E. 2010.

Figure 17.4. Edge of thicket of Afromontane bamboo (*Sinarundinaria alpina*; synonym: *Arundinaria alpina*) after mass-flowering near Masha (Ethiopia). In the national reference for Ethiopia, Afromontane bamboo was not described separately from Afromontane forest types in which Afromontane bamboo occurs; this image was included with images for Afromontane rain forest (Fa). Photograph by I. Friis and Sebsebe Demissew (January 2009). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 25F. 2010.

17.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 17. Species composition for Afromontane bamboo (B)

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda
Sinarundinaria alpina	dominant	f	D	f	D	D	D
Cornus volkensii	characteristic		C	f	f	C	f
Dombeya torrida	characteristic	f	x	f	f	C	C
Faurea saligna	characteristic		f	f	f	C	x
Hagenia abyssinica	characteristic	f	C	f	f	C	C
Ilex mitis	characteristic	f	f	f	x	C	C
Juniperus procera	characteristic	f	f	f		C	f
Lepidotrichilia volkensii	characteristic	f	C	f	f	C	x
Nuxia congesta	characteristic	f	x	f	f	C	x
Podocarpus latifolius	characteristic		x	f	f	C	C
Prunus africana	characteristic	f	f	f	f	C	f
Rapanea melanophloeos	characteristic	f	x	f	x	C	C
Tabernaemontana stapfiana	characteristic		f	f	f	C	f
Agauria salicifolia		f	x	f	x	f	x
Hypericum revolutum		f	C	f	f	f	x
Peddiea fischeri			x		f	f	x
Rhamnus prinoides		f	x	f	x	f	x
Rubus apetalus		f	x	f	f	f	x
Sambucus ebulus			x			f	f
Schefflera volkensii		f	C			f	f

18. Fresh-water swamp (X)

18.1. Description

Permanent swamps occur in depressions where water permanently floods the surface to a shallow depth (seasonal swamps are usually covered with edaphic grassland [see g]). Most of the shallower lakes outside the Guineo-Congolian floristic region (especially those that are not strongly saline, see halophytic vegetation [Z]) have a wide belt of reed-swamp where the dominant species are usually rooted in the soil and have stems that rise out of the water (inside the Guineo-Congolian region, most swampy areas are covered with swamp forest [fs]). The most abundant reed-swamp species is ***Cyperus papyrus*** (a giant sedge species) but other species can also be dominant such as ***Miscanthus violaceus***, *Phragmites australis* and *Phragmites mauritianus* grasses (White 1983 pp. 55 and 265).

True aquatic species occur in deeper water beyond the reed swamp and are either completely submerged or have floating leaves. A belt of floating grasses (principally *Vossia cuspidata, Paspalidium germinatum* and *Panicum repens*, but often invaded by *Cyperus papyrus*) frequently separates the reed-swamp from the aquatic vegetation (White 1983 p. 55).

Towards the landward margin of reed-swamp, often a narrow zone occurs of small trees and shrubs that are adapted to swamp conditions. The principal species are *Aeschynomene elaphroxylon, Aeschynomene pfundii, Ficus trichopoda* (scattered juveniles of swamp-forest trees), *Ficus verruculosa* (scattered juveniles of swamp-forest trees), *Kotschya africana, Mimosa pigra, Sesbania sesban* and *Syzygium cordatum* (scattered juveniles of swamp-forest trees; White 1983 p. 266).

Figure 18.1. Freshwater swamp in Morogoro District (Tanzania). Photograph by H. N. Moshi (2010).

Figure 18.2. Freshwater swamp dominated by *Cyperus papyrus* west of Mbale Town (Uganda). Photograph by J. Kalema (November 2010).

Figure 18.3. Freshwater swamp in Rwanda occurring at medium altitudes in that country in Akanyaru. Photograph by C. K. Ruffo (October 2009).

Figure 18.4. Typical East African birds of freshwater swamps and lakes within their natural habitat. Shell guide to East African birds (1960; reproduced with permission from URL *http://ufdc.ufl.edu/UF00077050*).

18.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Table 18. Species composition for Fresh-water swamp (X)

SPECIES	Regional status	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Acacia xanthophloea			x	x		f		
Aeschynomene abyssinica		x	x	f		f	f	f
Aeschynomene cristata		C	x	f		f	f	f
Aeschynomene elaphroxylon	trees on the landward margin of reed-swamp	C	x	x	f	f	f	f
Aeschynomene pfundii	trees on the landward margin of reed-swamp	C	x	x		f		f
Aeschynomene schimperi		C	x	f	f	f	f	f
Ceratophyllum demersum	submerged community in deeper water beyond the reed swamp		f	x		f	f	
Cissampelos mucronata		f	f		f	f	C	
Cyperus latifolius		f			C			
Cyperus papyrus	the main constituent of most of the shallower lakes (except those that are strongly saline) outside the Guineo-Congolian region (where swamp forests are more prominent); also in floating mats		C	x	C	C	C	C
Dissotis rotundifolia	principal associate of papyrus		f			f	C	
Echinochloa pyramidalis	species rooted in Vossia cuspidata mats (grass)		f	x		f	f	
Echinochloa stagnina	species rooted in Vossia cuspidata mats (grass)		f			f	f	C
Eichhornia crassipes	free-floating species, pest introduced from tropical America (the water hyacinth)	f	f	x		f		
Ficus verruculosa	juveniles of swamp-forest trees on the landward margin of reed-swamp		f	f	f	f	x	f
Heterotis canescens	associate of Miscanthus violaceus in shallower lakes in which papyrus is absent						C	
Hibiscus diversifolius	principal associate of papyrus	f	f	x	f	f	f	f
Ipomoea rubens			x	x		f	f	
Kotschya africana	trees on the landward margin of reed-swamp	f	x	x	f	f	f	f
Leersia hexandra	associate of Miscanthus violaceus in shallower lakes in which papyrus is absent (grass)	f	f	x		f	C	C
Lemna perpusilla	free-floating species		f	x		f	f	
Loudetia phragmitoides	in shallow water on the landward side of papyrus swamp (grass)		f			f	f	
Ludwigia leptocarpa	principal associate of papyrus			x				f
Ludwigia octovalvis	principal associate of papyrus		x	x				f
Ludwigia stolonifera	principal associate of papyrus			x				
Melanthera scandens	principal associate of papyrus		f			f	x	
Mikania capensis	principal associate of papyrus		f		f	f	x	
Miscanthus violaceus	in shallow water on the landward side of papyrus swamp; also forms a distinct zone in shallower water from which papyrus is absent (grass)						C	
Nymphaea lotus	community with floating leaves in deeper water beyond the reed swamp	f	f	x		f	f	
Nymphaea nouchali	community with floating leaves in deeper water beyond the reed swamp		f	x	C	f	f	
Oryza longistaminata	(grass)		f			f	f	C
Pennisetum macrourum	(grass)							C
Persicaria decipiens		f	f			f	C	
Phoenix reclinata	(palm species)	f	f	x	C	f	f	f
Phragmites mauritianus	common in silted areas and lakes of volcanic origin in East Africa (grass)		x	C		f	f	C
Pistia stratiotes	free-floating species	f		x				
Pycreus mundtii			f	x	C	f	f	
Sesbania bispinosa			x			f		
Sesbania sesban	trees on the landward margin of reed-swamp	C	x	x	f	f	f	f
Syzygium cordatum	juveniles of swamp-forest trees on the landward margin of reed-swamp		f	x	C	f	x	f
Typha domingensis			x	C		f	f	
Typha latifolia	locally replaces papyrus at higher altitudes		x				f	
Utricularia gibba	associate of Miscanthus violaceus in shallower lakes in which papyrus is absent		f	x		f	f	
Vallisneria spiralis	submerged community in deeper water beyond the reed swamp			x				
Vigna luteola	principal associate of papyrus		f	x		f	f	
Voacanga thouarsii			x	x			f	f
Vossia cuspidata	floating mat at the edge of reed-swamps, also pioneer of reed-swamp		f	x		f	f	

19. Edaphic grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type, g)

19.1. Description

White (1983)did not strictly apply a differentiation between edaphic wooded grassland (with cover percentages of 10 - 40% woody species) and edaphic grassland (with cover percentages of <10% woody species) since both types intergrade and edaphic wooded grasslands are often difficult to delimit from the more open grasslands with which they are associated (White 1983 pp. 50 - 52). **Within the VECEA map, we loosely [9] defined "edaphic wooded grassland" as "edaphic grassland with scattered woody species" and "edaphic grassland" as "edaphic grassland without scattered woody species". This means that some vegetation types that would have been classified as "edaphic grasslands" in a strict physiognomic classification system (i.e. woody cover < 10%) may have been allocated to "edaphic wooded grasslands"**.

The most widespread edaphic grasslands are those associated with seasonally or permanently waterlogged soils. They are limited in areas with short or no dry seasons (such as the Guineo-Congolian floristic region), but are widespread in regions which experience strongly seasonal rainfall (such as the Indian Ocean coastal belt and the Somalia-Masai, Sudanian and Zambezian floristic regions). Waterlogged soils usually occur in depressions which receive more water than is supplied by incident rainfall, but sometimes parent material has an overriding effect such as on edaphic grasslands that occur on volcanic soils (mapped as a distinct VECEA subtype [gv]; White 1983 p. 51). Alkaline grasslands that occur in basins are considered to be halophytic vegetation (mapped separately in VECEA as Z; White 1983 p. 100).

Although White (1983) described edaphic grasslands and wooded grasslands separately for the various floristic regions, we did not apply a floristic classification system to edaphic grasslands and edaphic wooded grasslands in the VECEA map.

Zambezian edaphic grassland[10] is widespread and occurs principally in four habitats: (i) seasonally waterlogged depressions on the Central African Plateau that are covered with edaphic grassland ("dambos"); (ii) flood plains of rivers and basins with internal drainage; (iii) Kalahari Sand of low relief; and (iv) sandy edges of dambos (White 1983 pp. 99 - 101):

Dambo grassland occurs above 1200 m and where there is seasonal flooding (some parts remain boggy throughout the year). The vegetation is usually a medium-dense grass mat of rather uniform appearance and height (50 to 100 cm with flowering culms of 1 to 2 m). ***Loudetia simplex*** is the most characteristic grass species and is dominant over large areas (White 1983 pp. 99 - 100).

9: among the exceptions that we made to the general rule, we did not include suffrutex grassland among wooded grassland types and neither did we include edaphic grassland on volcanic soils (gv) among wooded grassland types (although scattered Acacia mellifera may occur).

10: edaphic grasslands were studied in detail in several places because swarms of red locusts (Nomadacris septemfasciata) only originate from certain edaphic grassland areas. Four recognized major outbreak areas of the red locust are the Mweru-wa-Ntipa depression in Zambia and the Rukwa valley, the Malagarasi drainage basin and the Wembere de¬pression in Tanzania (Vesey-Fitzgerald 1963).

Flood-plain grassland occurs in the valleys of larger rivers where erosion has covered the valley floors with alluvium (mostly heavy clay) and where seasonal rainfall results in seasonal waterlogging. These valleys are covered with a complex and constantly changing mosaic of edaphic grassland, permanent swamp vegetation (X) and termite-mound thickets ("bush groups", see termitary vegetation [T]), which makes it very difficult to impossible to map these types separately. Floodplain grasslands can be subdivided into wetter types and better-drained types. The most extensive areas of floodplain grasslands of the Zambezian region occur in the Lake Chilwa basin of Malawi, the Malagarasi and Rukwa valleys of Tanzania, the Bangweulu and Mweru Wantipa basins of Zambia and the Chambeshi, Kafue and Upper Zambezi valleys of Zambia (White 1983 p. 100).

Kalahari suffrutex grassland is a short wiry grassland that occurs on oligotrophic Kalahari Sand that is seasonally waterlogged. Trees are virtually absent and have been replaced by rhizomatous geoxylic suffrutices that are usually less than 0.6 m tall. At least under the present conditions, their stems are burnt back to ground level every year. The underground parts are usually of massive proportions and greatly exceed the phytomass of grasses, so these communities can be described as "underground forests" although above-ground they look like grasslands most of the year. Most of the suffrutex species are closely related to forest or woodland tree or liana species. The most abundant suffrutex is ***Parinari capensis*** and the most widespread dominant grasses are ***Loudetia simplex*** and ***Monocymbium ceresiiforme*** (White 1983 pp. 100 - 101). Widely distributed suffrutices described by Fanshawe (1971 p. 45) to occur in catenary regression stages of Kalahari woodlands include *Annona stenophylla*, *Chamaeclitandra henriqesiana*, *Diospyros chamaethamnus*, *Diospyros virgata*, *Gardenia brachythamnus*, *Lannea edulis*, *Leptactina benguelensis*, *Napoleonaea gossweilleri*, ***Parinari capensis***, *Pygmaeothamnus zeyheri*, *Strobilanthopsis linifolia* and *Strychnos gossweileri*.

Most of the dambos are fringed by a narrow zone of sparse wiry grassland with abundant geoxylic suffrutices that are similar to *Kalahari suffrutex* grassland (White 1983 pp. 100 - 101). Fanshawe (1971 p. 52) describes suffrutex wooded grassland that occurs within a catenary sequence from Undifferentiated woodland (Wn) to grassland. Common suffrutices include *Annona stenophylla*, *Astripomoea malvacea*, *Brackenridgea arenaria*, *Combretum platypetalum*, *Cryptosepalum maraviense*, *Duosperma crenatum*, *Eriosema englerianum*, *Fadogia homblei*, *Gnidia kraussiana*, *Hibiscus rhodanthus*, *Ipomoea vernalis*, *Lannea edulis*, *Litogyne gariepina*, ***Parinari capensis*** and *Pygmaeothamnus zeyheri*.

Edaphic grassland in the Somalia-Masai floristic region was classified as edaphic wooded grassland, although treeless plains dominated by *Chrysopogon plumulosus* were described to occur in Somalia within deciduous bushland (Bd) and water-receiving depressions with black and cracking clays in Central Tanzania are treeless (but they are separated by an ecotone of wooded grassland, however; see edaphic wooded grassland [we]; White 1983 p. 116).

Edaphic grassland that occurs on volcanic soils is mapped and described as a distinct subtype (mapping unit gv; see below).

Edaphic grassland of the Zanzibar-Inhambane region was described as a edaphic wooded grassland (we) since woody trees occur (although widely scattered; these areas also contain thicket-covered termite mounts [mapping unit T]; White 1983 p. 189).

In most Sudanian edaphic grasslands there is an admixture of woody plants (White 1983 p. 107). Edaphic grasslands were not described by White (1983) for the Afromontane floristic region, although he stated that "there are undoubtedly small areas of edaphic grassland" (White 1983 p. 168). No mention is made of edaphic grasslands for the Lake Victoria regional mosaic.

19.2. Species composition

(Please check the methodology and information from Volumes 2 - 5 for more details on how the information on species composition for the different manifestations of this potential natural vegetation type was compiled. In composition tables, "x" indicates that the species is expected to be present, "C" indicates that the species was identified as characteristic species and "f" indicates a species that was not listed in the documentation that we consulted although it is known to occur in the specific country).

Figure 19.1. Edaphic grassland in Amboseli National Park (Kenya). Photograph by F. Gachathi (2008).

Figure 19.2. A typical dambo near Mbala (Zambia) with its centre of open grassland and fringe of small trees. In the background, Miombo woodland (Wm) with *Brachystegia microphylla* (a species virtually confined to rocky hills and escarpments, White 1983 p. 93). Burtt *et al.* (1942 p. 79) comment that "a dambo often gives the impression of a wide road through the general monotony of the Brachystegia forest" (i.e. miombo woodland [Wm]). Burtt *et al.* (1942, Photograph 7). Image obtained from URL: http://www.jstor.org/stable/2256690.

Figure 19.3. The "rain pond catena" in Tanzania was classified by the VECEA project as a catena of Somalia-Masai Acacia-Commiphora deciduous bushland and thicket (Bdd) / edaphic grassland on drainage-impeded or seasonally flooded soils (g). Although the water-receiving depressions are typically treeless grasslands, usually they are separated from deciduous bushland (Bd) by an ecotone of wooded grassland that is dominated by gall Acacias (especially *A. drepanolium, A. seyal, A. malacocephala* and *A. pseudofistula*; White 1983 p. 116; see also Gillman 1949 p. 29). Gillman (1949, Fig 30; this is one of the photographs that was cited by White (1983 p. 116) for Somalia-Masai edaphic grassland).

Table 19. Species composition for Edaphic grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type, g)

SPECIES	Regional status	Kenya	Malawi	gdT (Tanzania subtype)	gfT (Tanzania subtype)	gbU (Uganda subtype)	geU (Uganda subtype)	gsU (Uganda subtype)	Zambia
Acroceras macrum	Zambezian edaphic grassland (wetter types of floodplain grasslands)	f		f	C	f	f	f	x
Andropogon brazzae	Zambezian edaphic grassland (better-drained types of floodplain grasslands)			f	C				
Andropogon schirensis	Zambezian edaphic grassland (dambo grasslands, suffrutex grasslands)	f		C	f	f	f	f	x
Aristida adscensionis	Somalia-Masai edaphic grassland (clays plains in Somalia)	x							
Aristida stipitata	Zambezian edaphic grassland (suffrutex grasslands)								x
Bothriochloa bladhii	(grass)	f	x	f	f	f	f	f	x
Brachiaria brizantha	(grass)	f	x	f	f	f	f	f	x
Brachiaria humidicola	(grass)	f	x	f	f				x
Brachiaria jubata	(grass)					C	f	f	
Chloris gayana	edaphic grasslands of the Serengeti plains	f	x	f	f	f	f	f	x
Cynodon dactylon	Somalia-Masai edaphic grasslands; edaphic grasslands of the Serengeti plains	x	x	f	f	f	f	f	x
Cyperus dives	(sedge)	f		f	f	f	C	f	
Cyperus latifolius	(sedge)					f	C	f	
Cyperus longus	(sedge)	f	C	f	f	f	f	f	
Dichanthium annulatum	(grass)	f	x	f	f				x
Echinochloa haploclada	(grass)	x	f	f	f	f	f	f	x
Echinochloa pyramidalis	Zambezian edaphic grassland (wetter types of floodplain grasslands)	f	x	f	C	f	C	f	x
Echinochloa stagnina	Zambezian edaphic grassland (wetter types of floodplain grasslands)	f		f	C	f	f	f	x
Entolasia imbricata	Zambezian edaphic grassland (better-drained types of floodplain grasslands)	f	x	f	C	f	f	f	x
Eragrostis atrovirens	(grass)	f	x	f	f				x
Erianthus teretifolius	Zambezian edaphic grassland (dambo grasslands)			C	f				
Eustachys paspaloides	edaphic grasslands of the Serengeti plains	f		f	f	f	f	f	x
Fimbristylis dichotoma	(sedge)					f	f	C	
Hyparrhenia bracteata	Zambezian edaphic grassland (dambo grasslands)	f	x	C	f	f	f	f	x
Hyparrhenia diplandra	Zambezian edaphic grassland (dambo grasslands)	f		C	f	f	f	f	x
Hyparrhenia filipendula	(grass)	f	x	f	f	C	f	f	x
Hyparrhenia newtonii	Zambezian edaphic grassland (dambo grasslands)			C	f	f	f	f	x
Hyparrhenia nyassae	(grass)	f	x	f	f	f	f	f	x
Hyparrhenia rufa	(grass)	f	x	f	f	f	f	C	x
Imperata cylindrica	(grass)	f	x	f	f	f	f	f	x
Leersia hexandra	Zambezian edaphic grassland (wetter types of floodplain grasslands)	f	x	f	C	f	C	f	x
Loudetia kagerensis	(grass)	f		f	f	f	f	C	
Loudetia simplex	Zambezian edaphic grassland (dambo grasslands, better-drained types of floodplain grasslands, suffrutex grassland)	f	x	C	C	f	f	f	x
Microchloa kunthii	edaphic grasslands of the Serengeti plains	f		f	f	f	f	f	
Monocymbium ceresiiforme	Zambezian edaphic grassland (dambo grasslands, better-drained types of floodplain grasslands, suffrutex grassland)		x	C	C				x

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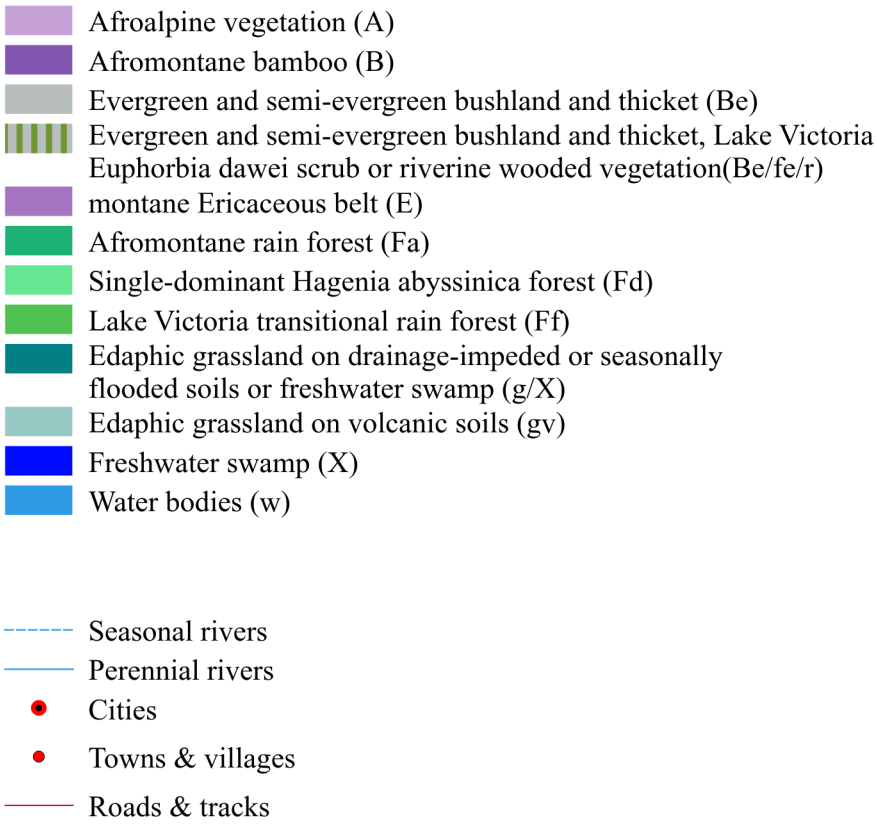

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